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## HARBOR IMPROVEMENT AT SAN PEDRO AND WILMINGTON, CALIFORNIA.

An important harbor, available for the largest class of vessels, is being created at San Pedro, Cal., about 400 miles south of San Francisco, and only 27 miles from the city of Los Angeles. The Southern Pacific Ry. and the San Pedro, Los Angeles & Salt Lake Ry. both have lines between San Pedro and Los Angeles, and as the recent completion of the latter road opens up a new transcontinental route with a deep water terminal at this point, it will give an impetus to the development of the city and the harbor. At present, however, the railway terminal facilities are not extensive or of special interest. Improvements by other private interests, such as filling in shoal areas, and building piers, wharves, etc., are contemplated or under construction, in both the inner and outer harbors.

The general situation, and the location of the improvement works now being carried out by the U. S. Government, are shown on the map, Fig. 1. The Bay of San Pedro was originally an open and exposed roadstead, with a shallow channel or estuary running up to a lagoon forming the harbor of Wilmington, so that Wilmington and San Pedro will form the inner and outer harbors of one port. The average range of tide is 5.1 ft. With the completion of the breakwater, the outer harbor will afford a place of refuge easy of access for vessels of the largest size, and secure from storms. The needs of the harbor are crowding its capacity, and companies are arranging to make large fills and extend wharves, etc., into deep water between the west jetty at the mouth of the inner harbor and the west end of the breakwater. The inner harbor is capable of being greatly extended and widened by dredging in Wilmington Lagoon. As the improvements of the inner and outer harbors form separate projects we will deal with them separately, taking Wilmington first, as the earliest improvements were undertaken at that point.

### INNER HARBOR AT WILMINGTON.

The original project for improvements at Wilmington, Cal., was to secure a depth of 10 ft. at mean low tide; this was approved in 1871, and the depth obtained in 1881, by the construction of jetties at a cost of $555,000. A further project was then approved for the increase of the depth of channel to 15 ft. by dredging a reef between the jetties, raising existing works, and extending the jetties to 18 ft. of water in San Pedro Bay. This work was completed in 1893, at a cost of $309,498. The River and Harbor Act of 1902 provided for a channel 20 ft. deep and 400 ft. wide from the outer harbor to the foot of the wharves, and 24 ft. deep between harbor lines from that point to and including a turning basin 1,600 ft. in diameter; this is the work now being carried out, and is shown in Fig. 1. The act also provided for the construction of a dike to divert the waters of the Los Angeles River from the Wilmington Lagoon, but subsequent changes in conditions rendered the building of this dike inadvisable. The estimated cost of the work, including a $100,000 dredge, was $550,000. The 2,048 ft. of discharge pipe line, together with pontoons, barges, launches and other floating plant, cost about $17,300. The River and Harbor Act of 1905 appropriated $100,000 for continuing the work and authorized contracts amounting to an additional sum of $150,000 for completing it. Work under these various projects has resulted in increasing the depth at the entrance from 2 ft. to over 18 ft., which is the maximum draft that could be carried into the harbor at mean low water up to the end of June, 1905.

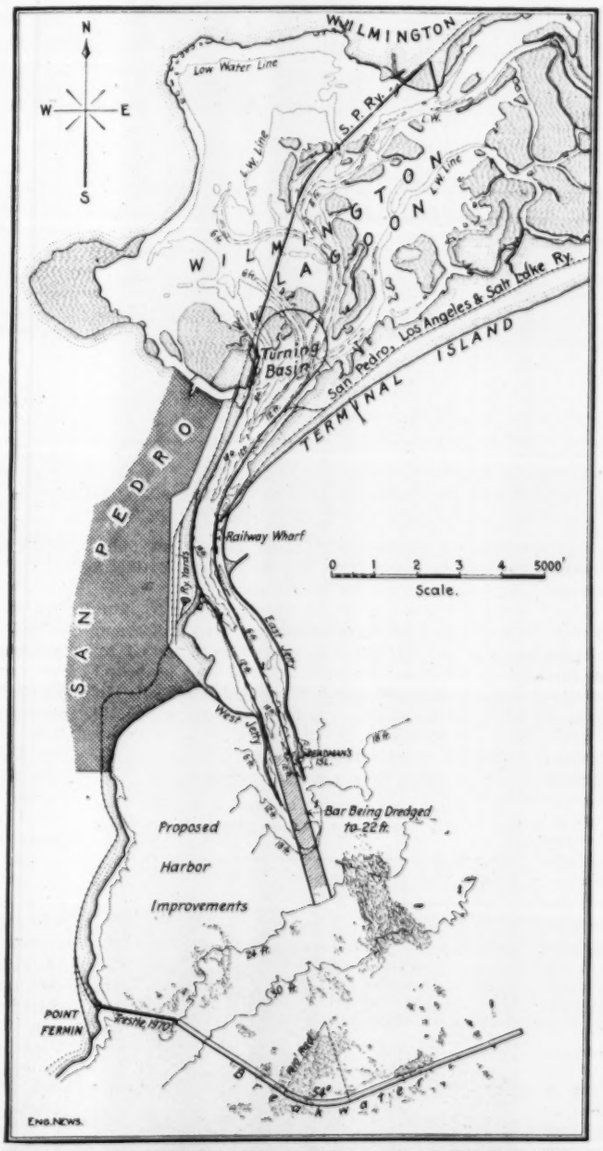



FIG. 1. MAP OF BREAKWATER, JETTIES AND DREDGED CHANNEL FOR SAN PEDRO AND WILMINGTON HARBORS, CALIFORNIA.

While the dredging was to be to a depth of 20 ft. between the jetties and 24 ft. in the channel, it is actually being carried to about 23 ft. over the bar and 25 ft. in the harbor. The dredging on the bar is being done under contract, at a cost of 46 cts. per cu. yd., the contractor operating a clamshell dredge with 3½-yd. bucket, dredging about 800 to 1,000 yds. per day. The material is composed of sand, shells and a dense heavy black clay, apparently impregnated with petroleum. As to the dredging work in the channel, we have the following information from Capt. Amos A. Fries, Corps of Engineers, U. S. A., Los Angeles, Cal.:

On the inside the dredging is being done with the suction dredge "San Pedro," designed and operated by the U. S. Engineer Department. The material is pumped through 1,500 to 2,500 ft. of pipe to the shore east of the harbor. Different companies have obtained leases from the local municipal authorities to the water front on the seaside along the southern portion of the harbor, and by means of bulkheads expect to reclaim a considerable amount of land with the material pumped up by the dredge. The dredge was completed and began work April 1, 1905, and up to March 31, 1906, had dredged 820,000 yds. of material of all sorts, from fine sand and silt, through tough black clay, beds of shells and yellow mud to cobblestones, coal and other refuse. The dredge is run continuously, except from Saturday midnight to Sunday midnight and national holidays. The quantities dredged per month have varied with the material, from 39,000 yds. to 125,000 yds. The cost, exclusive of depreciation of plant and interest thereon, has averaged about 7 cts. per yd.

The dredge is equipped with a 20-in. centrifugal, single-suction pump, with five blades, and has an inside diameter of 72 ins. This is directly connected to a 600-HP. triple-expansion engine arranged to run continuously at not more than 200 revolutions per minute. The rotary cutter is of simple cylindrical type, with heavy cast-steel cutters. In hard material the addition of heavy, flat bar-steel lugs to alternate cutters and to a ring projecting to the front have been found to largely improve the cutting capacity. The dredge has two spuds and moves forward by swinging alternately on these spuds in one direction only. All movements of the dredge, except starting and stopping the main engines, are controlled by the operator in the pilot house by means of levers. It is electrically lighted from its own electric plant, and the fuel used is crude oil entirely.

This dredge has proved very satisfactory, and has still about 2,000,000 yds. to dredge under the present approved project.

The hydraulic dredge "San Pedro" was built in 1904 for the U. S. Engineer Department by the Ellicott Machine Co., of Baltimore, Md., at a cost of $90,453, and is shown in Fig. 2. The hull was built at San Pedro by this company, and is of wood, with a framing of timbers of Oregon pine, machinery is about 750 tons. The triple-expansion main engine is of 600 HP., and the engine for driving the agitator or cutter-head is of 150 HP.

New wharves are being built for vessels of deep draft, and will extend into the outer harbor. We are also informed by Mr. D. E. Hughes, U. S. Assistant Engineer, that in the eastern end of San Pedro Bay or Wilmington Lagoon a harbor is under construction for the Los Angeles Dock & Terminal Co., by the North American Dredging Co., which has two or three dredges at work. It is intended to make this 30 ft. deep at harbor, below that of Wilmington, [illegible] by a breakwater opposite the entrance [illegible] latter. The River and Harbor Act of 188[illegible] vided for a survey of San Pedro Bay with [illegible] to establishing an outer harbor for the [illegible] tion of vessels of deep draft. The report o[illegible] included a project for the construction of breakwaters, at an estimated cost of $4,000,000. The River and Harbor Act of [illegible] ordered the appointment of a board of officers of the Corps of Engineers, U. S. A[illegible] examine the coast between Point Dume and [illegible] Capistrano, to select the best location for a

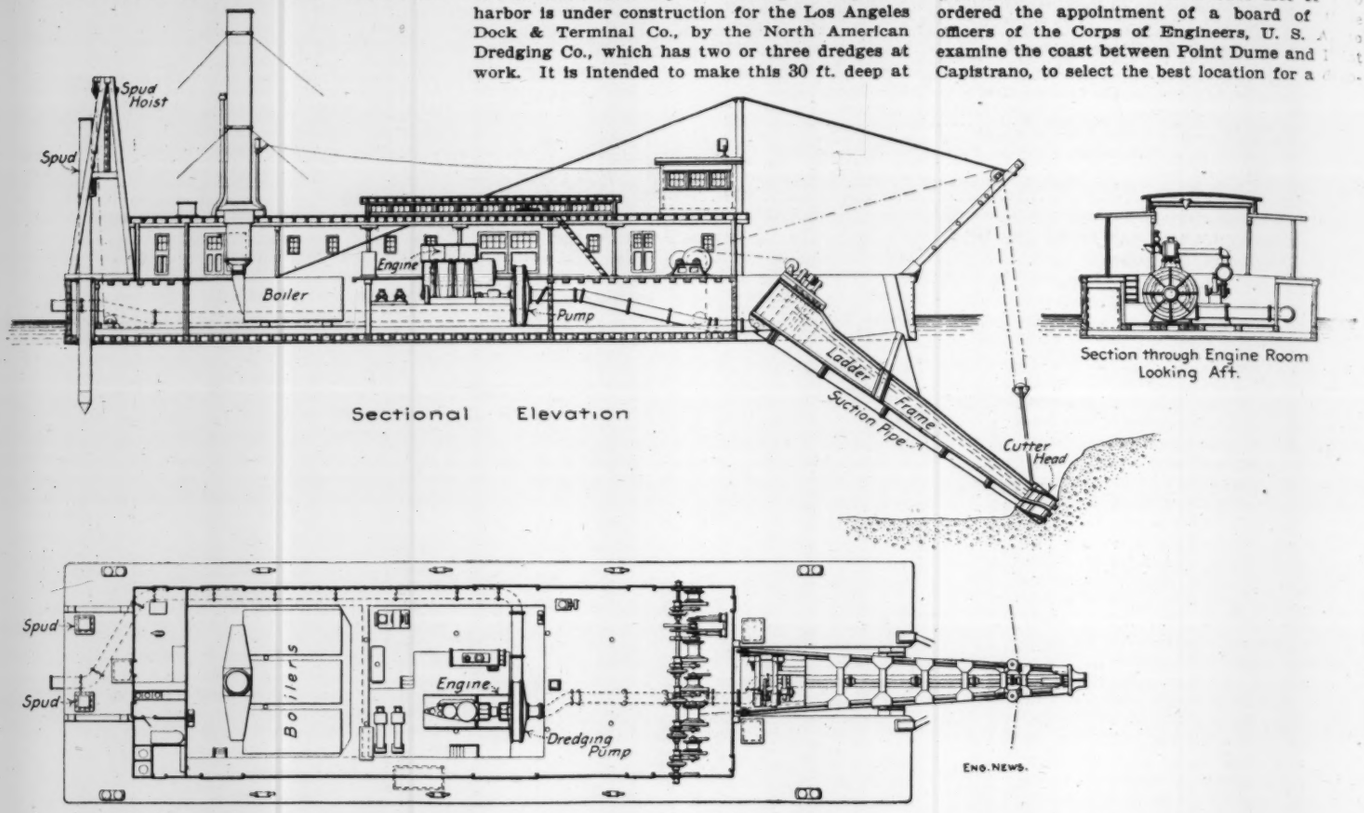



FIG. 2. HYDRAULIC DREDGE FOR HARBOR WORK AT WILMINGTON, CAL.
Ellicott Machine Works, Baltimore, Md.; Builders.

covered with heavy planking and sheathed with sheet copper. At the bow is mounted a steel ladder frame 55 ft. long, the inner end carried by hinge pins and the outer end suspended from a fixed A-frame by means of a wire cable, so that it can be raised or lowered; the maximum depth to which it will dredge is 35 ft. This ladder carries the 20-in. suction pipe and head, and also the shaft and gears for driving the agitator or cutter on the end of the suction pipe. This agitator consists of a cylindrical cage built up of forged steel rings and helical bars; on this are fastened the helical cutters or blades. The outer end of the cage surrounds and is attached to the cutter-head, which is secured to the end of the driving shaft; a smaller cutter is bolted on the outer face of the cutter-head. Fig. 3 shows the same style of agitator used on the government dredge "Cataract."

On the "San Pedro" the cutter shaft is driven through two pairs of spur gears and one bevel gear, all of steel. The agitator loosens and tears up the sand and gravel, which is then drawn into the suction pipe by the powerful current of water, and after passing through the 20-in. pump is discharged through a floating pipe line to the shore. In the 48-hour working test, previous to acceptance by the government, the dredge excavated and discharged about 500 cu. yds. of sand, shells, clay and gravel per hour, dredging from depths as great as 30 ft. below water level and delivering the material through 1,650 ft. of pipe line. The dredge is now worked night and day continuously for six days a week, with three shifts of men. The hull is 140 × 40 ft., with a depth of 11 ft.; and the total weight of hull and

The principal traffic of the harbor is in lumber, received by vessels from northern California, Oregon and Washington, and shipped inland by rail. There is also both inbound and outbound traffic in general merchandise and crude oil. In 1904 the commerce amounted to some 845,220 tons (an increase of 10% over 1903), with an estimated value of $9,000,000.

HARBOR AT SAN PEDRO.

As already noted, and as shown by the map, Fig. 1, the San Pedro harbor proper is an outer

Fig. 3. Cutter Head for Suction Dredge.

water harbor, and to prepare a general plan and estimate of cost for the works necessary for such a harbor. The board selected the western end of San Pedro Bay as the best location, and submitted a project for the construction of two breakwaters at a cost of about $4,500,000. Under the River and Harbor Act of 1892 a similar board, but composed of five engineer officers, was appointed to make a careful examination of San Pedro Bay and Santa Monica Bay, and to report which of these offered the most favorable location for a harbor to accommodate the largest ocean-going vessels and for commercial and naval purposes. This board also reported in favor of San Pedro Bay, on account of the greater natural protection afforded by the configuration of the shore, and also because the government had already spent a considerable amount of money upon the interior harbor at Wilmington, which would be a valuable adjunct to the new outer harbor. The plan proposed for this outer harbor was a single curved breakwater running out from the shore at Point Fermin, the cost of this being estimated at $2,885,000. There appears to have been still some doubt as to this harbor, and under the River and Harbor Act of 1896 another board was appointed to examine San Pedro Bay and Santa Monica Bay, its decision to be final as to the location of the harbor, and the Secretary of War then to enter into a contract for the construction of the breakwater, at a cost not to exceed $2,900,000. This board was composed of an officer of the U. S. Navy, an officer of the U. S. Coast and Geodetic Survey, and three civilian engineers. Like its predecessors, it selected San Pedro Bay, and for

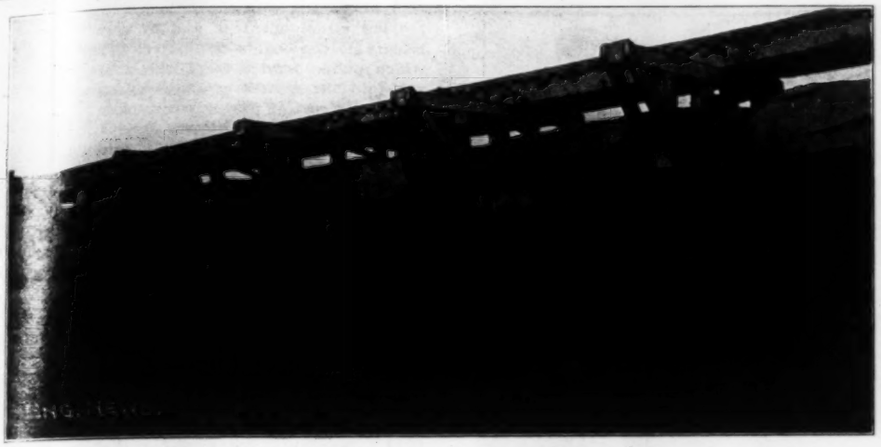


FIG. 5. OCEAN SIDE OF SAN PEDRO BREAKWATER.

the same reasons. It proposed a single breakwater, not touching the shore, and on a slightly different location from that previously proposed.

The breakwater was to be about 8,500 ft. long, or as much longer as could be built within the limit of cost ($2,900,000), and it has been decided to make it 9,000 ft. long. In plan it consists of two straight arms or tangents connected by a curve 1,800 ft. long, with a radius of 1,910 ft. The west arm is 3,000 ft. long, pointing S. 72° E. (magnetic); the east arm is 3,700 ft. long, and points N. 54° E. (magnetic). An opening of about 2,000 ft. is left between the end of the breakwater and the shore at Point Fermin, although the earlier report proposed a breakwater touching the shore. The breakwater is of rubble stone construction, of the cross-section shown in Fig. 4, which also shows the double track construction trestle. The superstructure is 38 ft. wide on the bottom, and 20 ft. at the top, its top being 14 ft. above mean low water. This superstructure is built of coursed blocks and formed with rough steps instead of a batter or slope. The work has been built very closely in accordance with the specifications, the stones on the harbor side being of such dimensions and so laid as to seldom depart more than 6 ins. from the offset lines as shown on the drawing. Fig. 5 is a view of the wall or face on the ocean side, built with blocks weighing over 16,000 lbs. each. Fig. 6 is a view of the wall on the harbor side, laid with blocks of 6,000 to 18,000 lbs. each. In the specifications it was assumed that each cubic yard of settled enrockment in the substructure would contain 1.25 gross tons of stone, and that each cubic yard of the superstructure would contain 1.75 tons of stone.

Each end of the superstructure is to be formed by a single monolithic block of concrete, 40 ft. square and 20 ft. high, with the bottom 3 ft. below the plane of mean low water. This is shown by the dotted lines in the cross section. The blocks are to be made of Portland cement, stone and sand in proportions of 1-2-4 for the part below high-water and 1-3-6 for the upper part. These have not yet been made. Experimental 16,000-lb. concrete blocks were made and placed in the water on the east side of the breakwater to determine the action of sea water upon the concrete. Some of the corners were broken slightly in dropping the blocks overboard, but the blocks show no sign of disintegration or of breaking up from wave action.

At first additional stone was deposited along the foot of the wall on the ocean side to form a berm, but this has been discontinued until there is some evidence of its being needed. There is, however, a berm 4 ft. wide on the inner or harbor side; this supplies a small reserve against slides, but its principal use is to ensure a foundation of full width for the bottom course of the harbor wall of the superstructure. In a paper on "Breakwaters" presented at the International Engineering Congress at St. Louis in 1904, by Capt. C. H. McKinstry, U. S. A., the following remarks were made in regard to berms on the inner and outer sides of breakwaters:

> The advantage of a wide berm of heavy stones on the ocean side is that the top of the substructure close to the foot of the ocean wall of the superstructure is protected from the backwash of the waves. Such a berm, however, cannot fail to trip the oncoming waves and cause them to strike a heavier blow against the superstructure. No necessity for a corresponding addition to the San Pedro breakwater has yet developed. For a time additional stone was deposited along the foot of the ocean wall, but this procedure has been discontinued pending some demonstration of its need.
>
> A berm on the harbor side as constructed at Delaware and San Pedro is a measure of precaution. The harbor slope of the substructure when formed of stone deposited at random depends upon the size of the stone and the height above water from which the pieces are dropped, and slopes that would be stable without a superstructure might not be stable with one added. The blows struck by the waves against the superstructure may cause the resultant of vertical and horizontal forces to pass dangerously close to the inner slope. Again, water which leaps the superstructure and falls close in to the foot of the harbor wall would tend to undermine this wall. At San Pedro a berm 4 ft. wide is being built. This supplies a small reserve against slides, but its principal use is to insure a foundation of full width for the bottom course of the harbor wall of the superstructure.

The first contract for construction was made in August, 1898, at the following prices: 54½ cts. per long ton for substructure, 72 cts. per ton for superstructure, $6.80 per cu. yd. for the concrete monoliths at the ends. This contract was annulled in March, 1900, on account of the slow rate of progress, and in June, 1900, a new contract was awarded to the California Construction Co., of Los Angeles, at 84.4 cts., $3.10 and $6 respectively; this company is now carrying on the work. Up to April 1, 1906, there had been placed 2,049,507 tons of stone in the substructure and 104,786 tons in the superstructure; this practically completed the former for 8,500 ft. and the latter for 3,932 ft. The work is now in such condition that protection against very serious waves is practically complete. No storm has yet injured any portion of the completed breakwater, and but few stones have ever been displaced along the uncompleted portions. Under the contract, the breakwater should be completed about Jan. 1, 1907, but it now appears that it will take a little longer. The approved lengthening of the breakwater to 9,000 ft. is included in the estimate of the time for the completion of the work. The contractors state that the material used is about 66% granite and 33% sandstone. The stones weigh from 100 lbs. upward, but most of them are from over 2 tons to as high as 14 tons each.

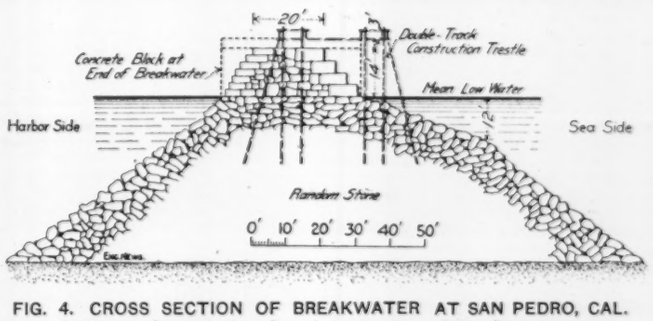



FIG. 4. CROSS SECTION OF BREAKWATER AT SAN PEDRO, CAL.
California Construction Co., Los Angeles, Cal.; Contractors.

The following description of the methods of carrying on the work is taken from the paper by Capt. McKinstry, already mentioned:

> Under the first contract stone was brought from Catalina Island, 22 miles distant, and was deposited from self-dumping barges. Under the present contract, the trestle method is used. Two kinds of stone are used for the substructure, viz., sandstone from Chatsworth Park, 60 miles from the site of the breakwater, and granite from Declez and Casa Blanca, 80 and 100 miles, respectively, from the work. The sandstone is placed in the lower and inner portions of the substructure. The stone thus far used in the superstructure is granite from Casa Blanca and Declez.
>
> The stone is loaded on standard flat cars at the quarries, and these cars are run out upon the trestle. The specifications require that, in the construction of the substructure, no stone weighing less than 100 lbs. shall be used. At least one-third shall weigh not less than 4,000 lbs. Actually there is much 10-ton and some 15-ton stone. The smaller stones, say up to a ton or more, are barred off the flat cars near the axis of the work, much of it in advance of larger stone, while most of the large stones are deposited by cranes, toward the sides of the

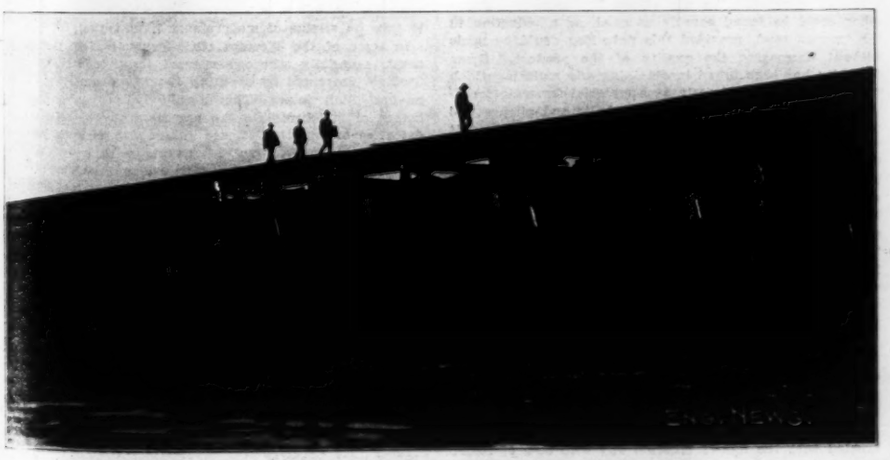


FIG. 6. HARBOR SIDE OF SAN PEDRO BREAKWATER.

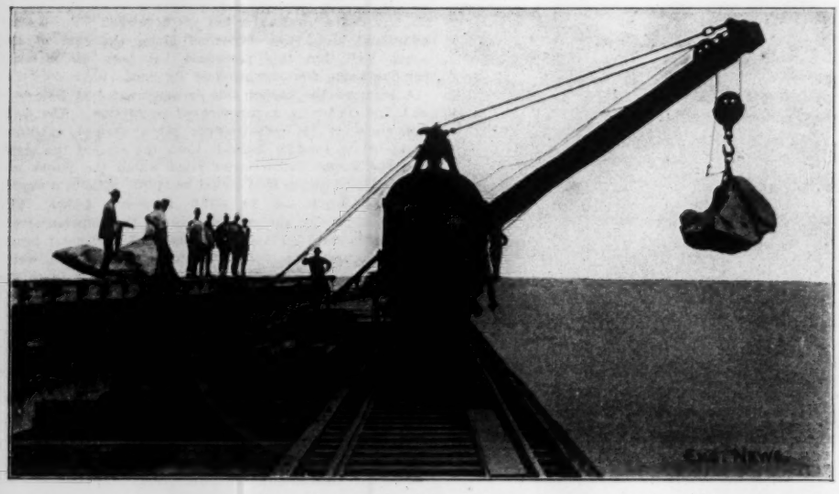


FIG. 7. DEPOSITING BLOCKS FOR THE SAN PEDRO BREAKWATER (SHOWING SLING AND TRIP).

structure. Thus, while the upper central portion is composed of all sizes over 100 lbs. mixed, the lower central portion consists mostly of small stone, and the two sides contain only large stone. Such segregation is not required by the specifications except for the upper portion of the sea slope, but is the result of the contractor's method of construction, and conduces to economy by increasing the voids. From the tonnage and specific gravity of the stone, and carefully sounded cross-sections, the percentage of voids has been computed to be 37½%. Under the circumstances this seems rather low, but the dropping of so many heavy stones tamps the mass, and there may be some settlement of the bottom. Besides this, the measured cross-sections are necessarily somewhat too small, for the sounding lead must often slide down into holes.

The cranes used are Barnhart steam shovels with special boom and hoisting tackle substituted for the shovels, and have a lifting capacity of perhaps 30 tons. More than 100 cars of stone have been unloaded in 10 hours by one of these cranes. There is an ingenious method of slinging the heavy stones in a chain of two branches which can be released by a trip-hook device worked from the engine room. The ocean wall of the superstructure is composed of stones weighing not less than 16,000 lbs. each, and the harbor wall of stones weighing not less than 6,000 lbs. each. Between these walls is a compact filling of stones of all sizes. The top of the superstructure is finished off with stones of large size.

## RECENT DEVELOPMENTS IN WOOD BLOCK PAVING

The rapid extension of the use of wood block pavements, of late, gives particular interest to the admirable review of recent developments in that field presented before the Municipal Engineers (Society) of New York, a short time ago, by Mr. F. A. Kummer,* M. Am. Soc. C. E. After outlining foreign experience with soft woods and also with the Australian hard woods, Karri and Jarrah, and after noting briefly the steps preceding the adoption by his company of 4 to 3½-in. rectangular long leaf yellow pine blocks, heavily treated with resin and creosote, Mr. Kummer passed to certain present day problems. The chief of these have been created by the growing scarcity and high cost of suitable yellow pine for paving blocks, and by the increase in the cost of resin from $1.40 to $4.70 per bbl. These conditions led to a search for a substitute for yellow pine and for a cheaper method of treatment. The results of this search are best given in Mr. Kummer's own language, as follows:

Ten years ago the average manufacturer of long-leaf yellow pine in the South would use every effort to obtain an order for one or two million feet of all-heart long-leaf yellow pine, cut from the best part of the tree and of a very superior quality. To-day there is not a lumber manufacturer in the United States, to my knowledge, who would accept such an order, and only at very high prices can lumber of good quality be secured. It is a well-known fact, for instance, that the density of yellow pine between the lower and upper parts of the tree varies as much as 30%, and yet to-day the lower and larger parts of the tree are being used for large-sized timbers, while the smaller and less dense parts are being cut up into paving block stock or material of a similar small dimension. Then, too, the exclusion of sap wood in the lumber has become and is daily becoming more and more difficult. These conditions would result either in the production of a paving block so costly that it could only be used on the most heavily traveled and luxurious streets, or in the production of a block which would be inferior in quality. Neither of these results were in any way desirable, and it therefore seemed evident that manufacturers of paving block must find a substitute for long-leaf yellow pine to avoid these conditions. The United States Government has also taken a very lively interest in this question, and through their suggestions as well as through those from other sources, it was concluded that one of the gum woods, existing largely in the South and known as black gum, possessed all the requirements for successful use as a paving material. This wood, on account of the difficulty in preventing it from warping and other inherent qualities, has been used very slightly for general purposes. It resembles the Australian hard woods [used for paving abroad], but while very dense in grain and tough, is not so hard as those woods and not so proof against decay. It was felt, however, that, properly treated, it would make a block, if anything, superior to Georgia pine, and actual tests in service indicate this to be the case. Blocks of this character have been laid for somewhat under a year on Hudson St. [New York City] between the tracks of the Metropolitan St. Ry. Co., between Dominick and Watts Sts., and are standing up under heavy travel, if anything, better than pine adjoining them in the same location. This wood possesses the great advantage of running uniform throughout, and is unlike yellow pine, in that it does not have the great distinction and difference in durability between sap and hard wood. I believe it will prove a most desirable and valuable addition to the timbers available for paving block purposes.

Returning to the question of the treatment, the advance in the price of rosin from $1.40 to $4.70 per bbl. naturally suggested the use of another material, if another could be found equally as good, or a reduction in the amount used, provided this reduction could be made without decreasing the quality of the product. Great difficulty has been found in obtaining any material which will take the place of rosin as a material for waterproofing and hardening the blocks. Asphalts and pitches will not mix with creosote oil, so that their use is in this way prevented; nor have they the advantage of hardening the fiber of the wood. A thorough investigation of the subject leads to the conclusion that the only way in which the amount of rosin used could be reduced would be by improving the quality of the oil. By increasing the gravity of the oil called for and greatly reducing the amounts that evaporate at given temperatures, a far heavier and denser and more permanent oil may be secured, and with the use of such an oil the amount of rosin may be safely cut in half. These statements are not made off-hand, but are the result of long and continued experimentation, both as to the possibility of securing thorough treatment with oils of this character and also and chiefly as to the waterproof qualities of the resulting product. It has been found that blocks treated with oils of this character, containing only 20 to 25% of rosin, are, if anything, more waterproof than blocks treated with the lighter creosote oils with 50% of rosin.

Passing on to other paving problems the author next dealt with the serious question of controlling street openings and of securing proper repairs to pavements thereafter. The freedom which public service corporations are given [or take] in the matter of street openings and the increasing cost of paving work make repairs under contractors' guarantees a serious matter. In New York it is almost impossible to repair paving except on Sundays, owing to the heavy street traffic. This means a lapse of many days between a cut in a street and the repairs thereto, during which wood paving blocks, loosened but back in place, are almost destroyed. Moreover, concrete foundations repaired on Sunday are often not "sufficiently set by Monday morning to withstand the heavy traffic which passes over them," and, the maintenance of barricades in down-town streets being impracticable, depressions result which require further repairs. More rigid control of public service corporations, in the matter of requiring their underground furniture to be put in order before streets are repaired, was suggested by the author. Pipe galleries for use by these corporations will doubtless be the ultimate partial solution of this problem, but the use of such galleries on an extended scale is probably far in the future. Meanwhile a heavy premium or charge on permits for street openings is desirable.

On the subject of Joints, Mr. Kummer says:

The question of the proper joints to use between wood paving blocks is one which has received a good deal of attention. Like many cases of a similar nature, it is impossible to generalize and say that any one form of joint is the best for all conditions. On streets where the travel is heavy the blocks are laid close together and the action of travel tends to expand the head of the block slightly, resulting in the closing up of the joints, so that the surface of the street is almost as homogeneous as the surface of an asphalt street and no crevices for the entrance of water exist. No wood block pavements will be affected by the water which runs over their surface, both because this water quickly flows to the gutter, if the street is properly graded, and because the surface of the blocks under travel become so dense and hard that they will not absorb water. Where water, however, can run under the block through the joints and remain for many days in the process of being soaked up by the pavement, expansion sometimes takes place, even with the most thorough treatment, this expansion resulting more from the character of the wood than from the character of the treatment itself. It has therefore been found that upon streets of light travel, where the traffic is not sufficiently heavy to cause this unification of the surface, either some form of water proof joint should be used or else expansion joints to take up any possible expansion of the block should be provided. In the Borough of Queens last year some 50,000 sq. yds. of block were laid on streets of very moderate travel in this way. Half-inch expansion joints were left along the curb and along the rail on streets with car tracks. These joints were filled with No. 4 paving pitch. Similar joints were placed across the street at intervals of 100 ft. It is very gratifying to note that not only has there been no evidence whatever of any swelling on these streets, but also that it does not appear that the expansion joint has been brought into play, as I have not been able to discover any evidence of its squeezing out, as would have been the case if the block expanded. This would seem to indicate that its use in this instance was unnecessary, but it is a precaution which I think it wise to take on streets of moderate or light travel.

In some of the Western cities expansion of the pavement, especially where blocks of light treatment were used, is prevented by grouting the whole surface with a paving pitch joint. This absolutely prevents the entrance of moisture into the pavement, but is open to a defect so serious that its use in this way is very limited. In spreading melted and hot paving pitch over the surface of the street and brushing it into the joints with squeeges a certain amount is left on the surface; under the action of the hot sun this becomes very sticky and disagreeable. In the nature of things it would be used generally on residence streets, these streets having usually moderate travel. If used on these streets, the results would be very unsatisfactory to the property owners, because as soon as the pitch gets sticky it is tracked into stores and houses and onto the sidewalks, to the great damage of carpets, etc. In the City of Baltimore some contracts have just been let in which an attempt will be made to pour the joints with paving pitch instead of spreading the pitch over the surface, but unless the blocks are separated so that the spout of the can from which the pitch is poured can be run along the groove, my own experience is that very few, if any, workmen can accurately pour joints of this character without getting more pitch on the surface than they do into the joints.

*Chief Engineer U. S. Wood Preserving Co., 29 Broadway, New York City.

If the pitch is spread over the surface in very hot weather and the greatest care is taken, not only to leave as little as possible on the surface when sweeping it into the joints, but also to put sand over the surface of the street while the pitch is hot, this surface pitch will be ground off by the action of travel within a reasonably short time, but even during that period the complaints from its use will be very numerous. Still another consideration arises in the case of these joints which may not be apparent at first thought. On prominent business streets in this city [New York], if the joints are to be made with sand, it is not practical to leave a coating of sand on the street long enough for it to work into the joints by the action of travel. This results from the fact that this sand is constantly being blown into the faces of pedestrians and into stores and office buildings, to the great dissatisfaction of the public. Therefore the specifications of the City of New York, Borough of Manhattan, call for a cement joint between the blocks instead of sand. This joint, inasmuch as it is run between the blocks in the usual manner, is very quickly applied, and the surface of the street may be swept clean of the sand top dressing within a short time. In fact, under these circumstances there seems very little necessity of using much, if any, sand top dressing, except for the purpose of filling up those few joints which the grout has not thoroughly filled.

On the subjects of length and depth of blocks Mr. Kummer said:

In the beginning of the wood block industry in the East blocks of uniform lengths of 8 ins. were called for and have been called for for the past five or six years. The Western practice, on the contrary, has in many instances admitted blocks running in lengths from 6 to 10 ins., or even 12 ins. I am inclined to believe that this provision is a very wise one, inasmuch as the length of the block has no direct relation to its wearing qualities, and it is possible to more readily obtain a lumber supply with planks ranging, say, from 6 to 10 ins. in width, than by being obliged to buy all planks of the one width. As far as the depth of the block is concerned, I believe that blocks 3½ ins. in depth, of proper material and properly treated, will be quite as serviceable as 4-in. blocks, as the rate of wear is very small, and either would probably become unserviceable after 1 or 2 ins. of the surface had worn off and this amount of wear would not occur in a very long period of time. For decreasing the cost of the pavement on less important streets 3-in. blocks have been very successfully used, but there are mechanical objections to using blocks of less depth than 3 ins., as they have not sufficient depth to bind them properly in the street.

Constant sprinkling of wood block pavements is undesirable, since it softens the fiber, allows the traffic to pound out and the water to wash out the preservative, all of which tends to decay and wear. Instead of trying to cut down the dust the latter should be kept from accumulating, to which end light sprinkling, before sweeping, is, of course, permissible.

In conclusion, Mr. Kummer said:

The mortar bed as a substitute for the sand cushion, used abroad extensively, and first suggested in New York City by Mr. Geo. W. Tillson, Chief Engineer of Highways of the Borough of Brooklyn, has proved in every way a decided advance over the sand cushion. It will not hold moisture to any appreciable extent, and it cannot shift, and always maintains the block in a rigid position. Wood block, being in itself elastic, requires no cushion, as would be the case with stone or brick, but while wood block pavements have a very long life, if the individual blocks which compose the street are kept perfectly to grade, it is one of the most easily destroyed pavements in the world if the surface becomes uneven, and this can never be entirely prevented where a sand cushion is used.

## THE COST OF ROCK EXCAVATION UNDER WATER ON THE DETROIT RIVER.

The subject of submarine rock excavation has become of especial interest recently in connection with the estimates for the Panama Canal. In the discussion over these estimates a wide difference of opinion developed as to the cost of such work. The following information relative to the work now in progress for deepening the channel of the Detroit River has therefore been compiled. Most of the data are taken from the Annual Report of the Chief of Engineers for 1904-5.

SECTION 2, LIME KILN CROSSING.—The object of this improvement is to provide a clear depth of 21 ft. (at a Lake Erie stage of 570.8 ft.) throughout the west 300 ft. of a 600-ft. channel at Lime Kiln Crossing. Under this project the channel lines are changed from those of former projects, in order to straighten the channel while still taking advantage of former improvements. The material to be removed is mainly limestone bedrock, all requiring to be drilled and blasted before being removed. The estimated cost of this improvement is $430,625.

This work is being performed by G. H. Breymann & Bro., of Toledo, O., under formal contract dated April 5, 1904, the contract prices being $3.25 per cu. yd., bank measurement, for all material above the 22-ft. grade, and $1.625 per cu. yd. for all material removed between the 22 and 24-ft. grades.

Work under this contract was commenced on July 29, 1904, continued until Dec. 12, 1904, resumed on March 30, 1905, and continued to June 30, 1905. The plant used was as follows:

| | Hours Worked. | Hours Delayed. |
|---|---|---|
| Dredge "Tipperary Boy" | 8 | 28 |
| " "Brian Boru" | 986 | 364 |
| Drill boat "Earthquake," with 4 drills.. | 2,853 | .. |
| " " "Cyclone," with 2 drills..... | 3,473 | .. |
| One derrick scow, with diving outfit.... | 25 | .. |
| Two tugs, and the necessary dump scows. | | |

There were removed from an area of about 23,000 sq. yds. 13,003 cu. yds. of full-rate material (above 22-ft. grade); 17,578 cu. yds. of half-rate material (between 22 and 24-ft. grades;; and 2,645 cu. yds. of material for which no payment can be made (below 24-ft. grade).

The amount earned by the contractors was $70,284.

Over an area of about 39,000 sq. yds. the material was broken up by drilling and blasting. The holes were generally drilled at the corners of 5-ft. squares. The number of holes drilled was 17,212, being 165,011 lin. ft., and 170,669 lbs. of dynamite were used.

SECTION 4, AMHERSTBURG REACH AND HACKETT RANGE.—The object of this improvement is to provide a clear depth of 21 ft. (at a Lake Erie stage of 570.8 ft.) along Amherstburg reach and Hackett range for a maximum width of 600 ft. and a minimum width of 300 ft., covering a channel of about 3 miles. The channel lines under this project are changed from those of former projects in order to straighten the channel, while still taking advantage of former improvements. The material to be removed is limestone bedrock, loose stones and boulders, clay, and sand. The estimated cost of this improvement is $804,000.

This work is being performed by M. Sullivan, of Detroit, Mich., under formal contract dated May 31, 1904, the contract prices being $2.40 per cu. yd., bank measurement, for material above the 22-ft. grade, and $1.20 per cu. yd. for material between the 22 and 24-ft. grades. Work under this contract was commenced May 24, 1904, continued until Dec. 12, 1904, resumed on March 21, 1905, and continued to June, 30, 1905. The plant used was as follows:

| | Hours Worked. | Hours Delayed. |
|---|---|---|
| Dredge "Old Glory" | 1,464 | 426 |
| " "Hercules" | 1,756 | 649 |
| " "Gladiator" | 765 | 358 |
| " "Tipperary Boy" | 1,403 | 773 |
| Drill boat No. 2, with 3 drills..... | 4,584 | ... |
| " " "Dynamiter," with 3 drills... | 4,427 | ... |
| " " "Tornado," with 2 drills..... | 3,650 | ... |
| " " "Cyclone," with 2 drills..... | 198 | ... |
| One derrick scow with diving outfit.... | 339 | ... |
| Three tugs and the necessary dump scows. | | |

Over an area of about 120,000 sq. yds. the material was broken up by drilling and blasting. The number of holes drilled was 36,479 at the corners of 5-ft. squares, being 260,313 lin. ft., and the number of pounds of dynamite used was 328,444.

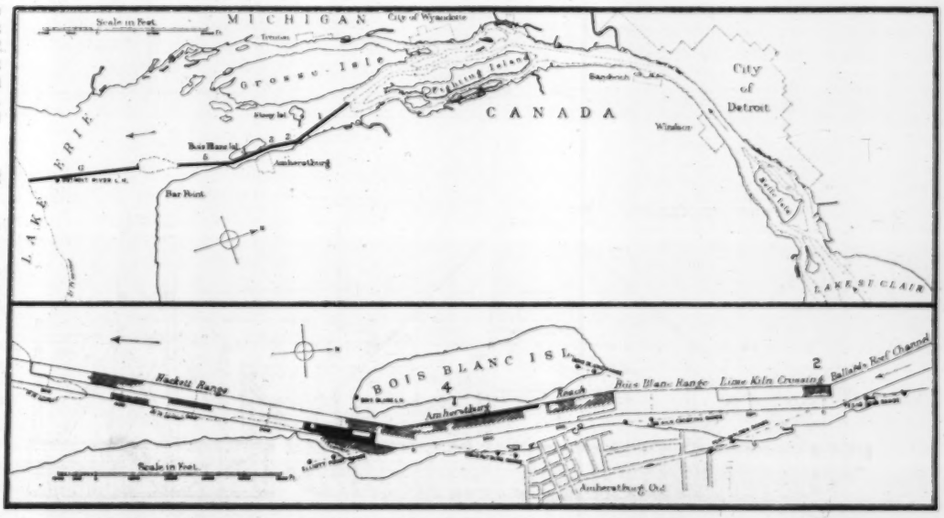
During the year 1904-5 there were removed from an area of about 225,000 sq. yds. 78,260 cu. yds. of full-rate material (above 22-ft. grade); 100,893 cu. yds. of half-rate material (between 22 and 24-ft. grades); and 43,482 cu. yds. of material for which no payment can be made (below 24-ft. grade).

The amount earned by the contractor was $308,895.60.

By way of comment on the above, it may be noted that in Section 2, Lime Kiln Crossing, the number of holes drilled was 17,212, being 165,011 lin. ft., showing an average depth of 9.6 ft. per hole. There were used 170,669 lbs. of dynamite, or 9.9 lbs. per hole, a little more than one pound for each foot of hole. There were removed from an area of 23,000 sq. yds. 33,226 cu. yds. of material, which would give an average depth of 4.2 ft. This demonstrates that the holes must be drilled to a depth over twice that of the material to be removed. The total hours worked by the drill boats for all drills was 18,358. This is at the rate of 9 ft. per hour, a remarkably good showing.

On Section 4, Amherstburg reach and Hackett range, the number of holes drilled was 36,479, being 260,313 lin. ft., showing an average depth of 7.1 ft. per hole. There were used 328,444 lbs. of dynamite, or 9.0 lbs. per hole, a little over 1¼ lbs. for each foot of hole. There were removed from an area of 225,000 sq. yds. 222,635 cu. yds. of material, which would give an average depth of nearly 3 ft. The holes in this case also were over twice the depth of the removed material. The total hours worked by the drill boats for all drills was 34,729. This is at the rate of 7.5 ft. per hour, or considerably less than on Section 2.

STEEL PASSENGER CARS are to be installed on the Southern Pacific Ry. as fast as they can be obtained from the builders. Tests made by this railroad have shown that such cars can be made as easily, and, considering the benefits afforded, as cheaply as wooden cars. They will be lighted by electricity generated from the car axle. The cars are built according to plans furnished by the Southern Pacific Co. and are only about 10% heavier than a similar wooden car.




MAP OF DETROIT RIVER, SHOWING LOCATION OF CHANNEL IMPROVEMENT WORKS NEAR BOIS BLANC ISLAND.

## BUCKET DREDGES AND DREDGING FOR GOLD IN AUSTRALIA.*

By E. Seaborn Marks and Gerald N. Marks.

In view of the growth of the bucket-dredging industry in different parts of the world, and of the meager nature of the literature on this subject, some description of the construction of plants, and of dredging areas, and of the actual operation of a dredge, may prove of interest to those who have not had the opportunity of becoming familiar with this class of mining. And it is with the desire of giving such information that this paper is written. The subject may conveniently be discussed under the following headings:

(1) Bucket dredges and their construction.

(2) Alluvial deposits suited to bucket-dredging, and the requisite conditions for successful operations.

(3) Dredging operations and costs.

### BUCKET DREDGES AND THEIR CONSTRUCTION.

The different types of bucket dredges vary only in the methods adopted for saving the gold and stacking the tailings. The simplest form is known as the sluice box dredge, on which the gold is caught in a long sluice run fitted with ripples, into which the buckets tip their burden. The other type is called the screen dredge, which, as the name suggests, is provided with a revolving screen or trommel, through which the material raised is washed onto tables running athwartships and discharging astern of the dredge in a semicircular shute. The coarser material passes out of the screen into a tail shute, also to be deposited astern either by passing over a sluice run or being conveyed in the trays of a tailings elevator.

Each type of dredge is specially adapted to certain working conditions. The screen and elevator will work under either, but the sluice box only under that in which there is little or no depth of material to be dredged above water-line. The latter is the cheaper dredge both to build and work, as less boiler power is necessary and the wear and tear of the plant is nothing like as great. It is found in dredging that the material turned over will occupy a third more space when stacked behind the dredge than before breaking.

In designing a dredge, the pontoon first comes under notice, and its construction requires careful consideration so that it may be built with sufficient strength to withstand the work required of it. A total of 50,000 to 70,000 sup. ft. of timber are used in building a pontoon, which will measure from 70 ft. to 90 ft. or more in length, about 30 ft. in width, and 6 ft. 6 ins. in depth. These dimensions vary with the weight of machinery and the general arrangement and design of the plant.

The Australian hardwoods are excellent material for pontoon construction on account of their strength and durability. The weight of this class of timber might be an objection should a shallow draft be required; in this case Oregon pine would be preferable for planking, with hard wood framing. Pitch pine should be used for framing in place of Oregon if hardwood is not procurable, as Oregon does not securely hold spikes and will not stand the jar of a heavy hammer in driving spikes and bolts. In the drawings of pontoons shown, all framing is hardwood; it would have been necessary to increase the dimensions of the framing by one-third had soft wood been used.

Three different constructions of pontoons are given in Figs. 1, 3 and 6, the details of which require no special comment, except that in the case of Fig. 1 the plan shows a pontoon constructed of hardwood, with the bottom and side planking bolted and spiked to the framing throughout, and provided with an inner skin of Oregon, which, although greatly adding to the strength, cannot be recommended on account of the difficulty of getting at the sides if any leakage occurs in the caulked seams. On this pontoon is illustrated the "A" class of tumbler frame; all framing above decks is constructed of Oregon. It was on this pontoon that the plant shown in Fig. 2 was erected.

Fig. 3 shows the pontoon designed to carry the machinery shown in Fig. 4, and is constructed with Oregon planking, spiked to hardwood framings, and can be recommended as a cheap and effective design, suited to most classes of dredging. This illustration shows the square tumbler frame built of Oregon with diagonal struts forward, placed at an angle of 45° to the tumbler frame, and on the lower diagonal the ladder is pivoted, and can be moved up and down to alter the dredging depth.

A pontoon built on somewhat different [illegible] with diagonal and cross braces, is illustrated in [illegible] signed in connection with the plant shown [illegible] This pontoon is also built with Oregon pla[illegible] hardwood frames, and is suitable for working [illegible] low ground. The Oregon framings above decks [illegible] Fig. 7 are of similar construction to those of th[illegible] design. An extra frame to strengthen the w[illegible]

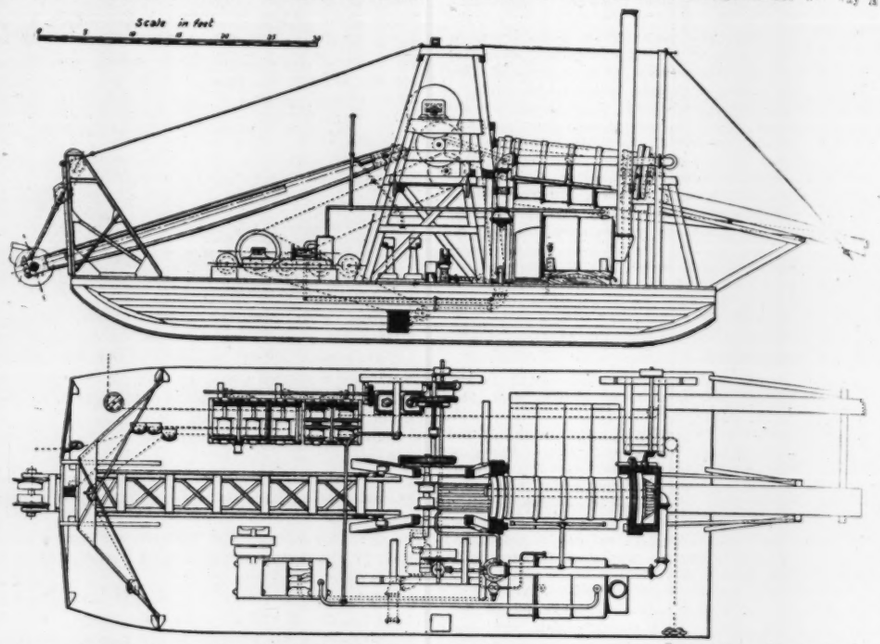



FIG. 2. PLANS SHOWING ARRANGEMENT OF DREDGING MACHINERY ON PONTOON SHOWN BY FIG. 1.

placed between the tumbler frame and gantry. The gantry from which the ladder is swung in Figs. 2 and 4 is constructed of steel, but in the Fig. 7 design is built of Oregon and is tied back to the tumbler frame. The frames above decks at the stern in all cases carry either the sluice box or screen, and those on either side of the tumbler frame the shafting and gearing.

As a general remark it may be stated that the heights of the framing above deck will depend, in the case of the gantry, on the length of the ladder, sufficient height being allowed for the bottom tumbler to be raised out of the water and taken off for repairs from time to time. The height of the tumbler frame depends on the height of the bucket discharge, that is to say, about 5 or 6 ft. to the drop plate. With a sluice box dredge it is high, and in the case of a screen dredge lower, when a tailings elevator is used. Sufficient head room also should be allowed for working tackle for removing the top tumbler.

All pontoons are coated with tar, to preserve the timber, after the seams have been caulked and pitch payed in. The framings above deck should be given a coat of boiled oil and then painted with hematite paint. As a protection forward from sunken logs and the wearing of the corners of the dredge, and aft to take the wear of the dredge dragging on the tailings, all pontoons should be steel-plated with ⅛-in. steel plate for 6 ft. at either end. In countries where transport is difficult and skilled labor scarce, pontoons are constructed of steel plates and girders. These pontoons are built in the works and afterwards taken to pieces and shipped to the mines in sections, of such weights as can be conveniently transported.

Figs. 2, 4 and 7, previously referred to, illustrate the machinery and general arrangement of three different plants. Fig. 2 shows a screen dredge with a discharge into a sluice run, which could be replaced by an elevator if occasion warranted, in which case the screen would be lowered to within a few feet of the deck, and power saved in pumping up the water for washing purposes.

Fig. 4 illustrates the sluice box dredge in its simplest form, and requires no special comment. With this design Fig. 5 shows the housing arrangement and top covered deck.

In Fig. 7 a combination of sluice box screen [illegible] elevator is illustrated. The wash passes first over [illegible] sluice run, thence to a travelling screen, which is ma[illegible] up of perforated trays attached to an endless wire r[illegible] and worked with sprocket wheels. We designed th[illegible] screen some five years ago, and it has given most sa[illegible] tory results in practice, and is found to be preferable [illegible] a revolving trommel, as it can be lengthened to [illegible] y out astern and do the combined work of a screen a[illegible] ailings elevator.

*A paper read before the Institution of Mining and Metallurgy of Great Britain on April 19, 1906.

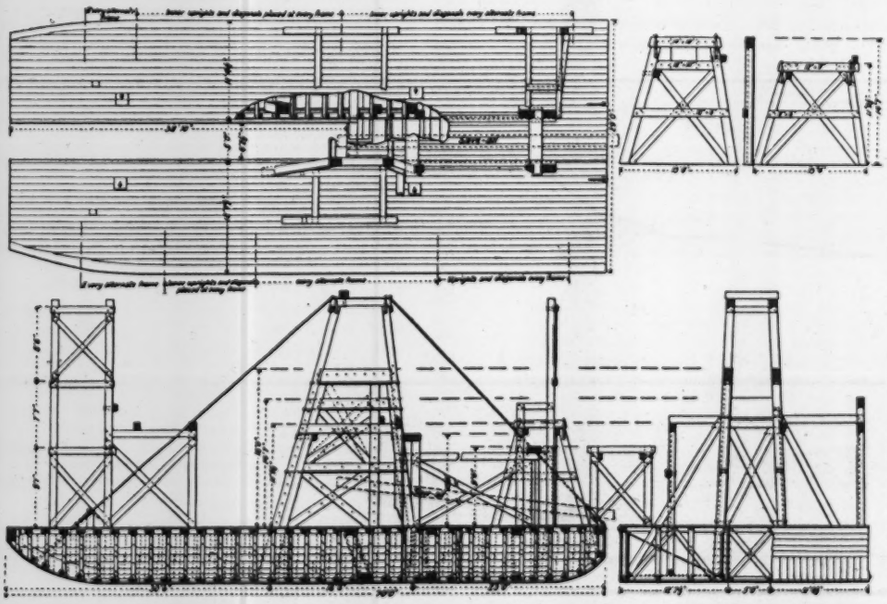


FIG. 1. DREDGE PONTOON WITH HARDWOOD FRAME AND OUTSIDE SHEATHING OF HARDWOOD AND INSIDE SHEATHING OF PINE.

The finer material passing through the screen trays falls into a distributing box and passes on to a double set of tables, which discharge through launders on either side of the dredge astern; the coarser material falls from the end of the traveling screen on to a tail shute and into the buckets of an elevator.

In this plant it will be noted that helical gearing is used. Some designers do not favor it, but we have found that, if carefully and strongly erected, it has the advantage of being noiseless, and the back lash of the buckets when working in heavy ground has not so much effect on this class of gearing.

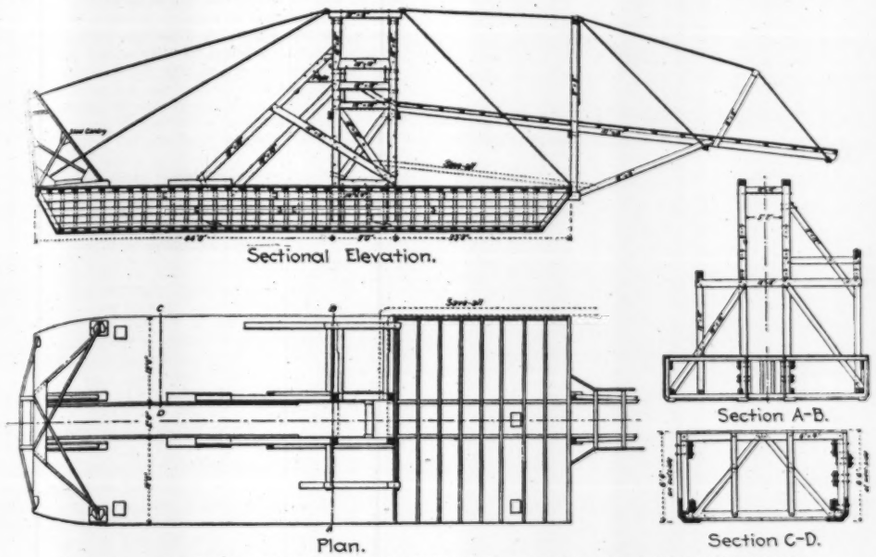



FIG. 3. DREDGE PONTOON WITH HARDWOOD FRAME AND PINE SHEATHING.

The cost of building the foregoing plants and pontoons is given as under, but it must be understood that these prices will vary with the cost of transport, labor and such items:

(1) Pontoon as shown in Fig. 1, $5,750. Complete plant, Figs. 1 and 2, $32,500.*

(2) Pontoon as shown in Fig. 3, £850. Complete plant, Figs. 3, 4 and 5, $27,500.

(3) Pontoon shown in Fig. 3, $4,250. Plant complete, Figs. 6 and 7, $30,000.

In describing the following parts of the machinery and gear of a dredge under their separate headings, that shown in Fig. 2 has been taken as a model.

THE LADDER.—The ladder, on which the buckets run, varies in length according to the depth of ground to be treated and the height at which it is hung from the tumbler frame. It should be of such length, in all cases, that when the buckets are working on the bottom it hangs at an angle of 45°, as in this position the buckets will give the best working results.

The following description is of a ladder with 50 ft. centers, which works to a depth of 30 ft. below water-level, and is designed with its fittings to carry buckets of 4½ cu. ft. capacity. It is 4 ft. wide and made with ⅜-in. steel side plates, 30 ins. deep at the center and tapered 20 ins. at the edge; the top and bottom edges have 4 × 4 × ½ in. angle steel rivetted inside. As few joints should be made in the side plates as possible; where joints occur they are butted and strapped inside with ⅜-in. plates, 24 ins. long behind each butt; the angle irons have joints of not less than 2 ft. from the butts of the plates strapped with bosom straps 12 ins. long.

Cross bulkheads of ⅜-in. steel plate are placed every 6 ft. between the side plates of the ladder and are secured with 3 × 3 × ⅜-in. angles to the sides. The use of the bulkhead is to take the side strain on the ladder caused by the buckets when the dredge is working across its paddock. Cross plates of 12 × ⅜ in. steel are fitted across the ladder on the top and bottom, and are rivetted to the side angles and bulkheads with 3 × 3 × ⅜ in. angle steel. Inside diagonal braces of 3 × 3 × ½ in. angle steel are rivetted and fitted to the ladder between the bulkheads.

The upper end of the ladder is fitted with steel adjusting screws 3½ ins. diameter (square threads), the screws are fitted with double nuts and have strong castings (through which they are slid) securely rivetted to the ladder side plates. Slots cut in the side plates, with 2½ × 2½ × ½ in. steel plate rivetted along the edges, form a space in which the ladder pivoting shaft is swung.

The screws and slots allow a travel of 18 ins. for the pivoting shaft, which is 5 ins. diameter, and passes through two plates 15 × 12 × ¾ in. bolted to the ladder side plates by ⅞-in. bolts, which take the strain off the extension screws and holes made along the ladder plates for adjustment.

The lower end of the ladder is double-plated with ½-in. plates of a length of 6 ft., and has bars of steel 5 ft. 9 ins. long × 3½ ins. tapered to 1 in. at the inner end fitted into the angle steels. Plates of ¾-in. steel 2 ft. 6 ins. × 20 ins. are rivetted through the square bars, and have lugs formed on the top to hang the ladder.

Slots are made in the square bars and fitted with gibs and cotters. Castings of hard cast-iron, not machined, are fitted at the lower end in which the bottom tumbler works. A chafing piece of hard wood 30 ft. long × 9 ins. × 5 ins. is bolted to each side of the ladder and a bar of half-round iron 2½ ins. × ¾ in. is secured outside of the timber.

LADDER FITTINGS, BOTTOM TUMBLER.—The bottom tumbler is made with five working faces and consists of two cast-steel cheeks, which are bored out and fitted to a steel shaft secured with two keyways at each end; the ends of the shaft are bushed with turned steel bushes shrunk on, which should be of the hardest possible material.

We have found that a great improvement is effected by making the shaft hexagonal for the length covered by the bush and slipping on a bush cast hexagonal on the inside to fit. At the ends of the shaft steel collars are fitted and secured by 1-in. steel pins driven through the collar and shaft; the shaft runs in the cast-iron bearings fitted to the lower end of the ladder. At times the bottom tumbler is cast in one piece instead of the foregoing design, and is made of cast-iron and revolves on the shaft.

This is a cheaper tumbler to make, but the wear and tear is much greater and the life is not half that of a steel tumbler of the above design, which, under favorable conditions, would wear for three or four years, while twelve months would be the limit for that of cast-iron.

LADDER ROLLERS.—These are made of chilled cast-iron 12 ins. in diameter and keyed for 2-in. diameter steel spindles having steel bushes shrunk on the end, which run in hard metal bushes fitted into cast-iron chairs bolted on to the ladder. The rollers are put on every 6 ft. along the ladder.

It is found that by shrinking on 2½-in. steel bands 8 ins. wide, or the exact width of the tread of the bucket and links, a great improvement in the economy of working could be effected, inasmuch as the rollers, if occasionally re-bushed, will last for years, where otherwise their duration would be but a few months.

HANGING GEAR.—The ladder is hung on a 7-ft. shaft, 5 ins. in diameter, which is passed through the eyes of the two adjusting screws and rests in two strong rough castings which are bolted to the tumbler framing. The lower end of the ladder is swung from the gantry as follows: Two hanging bars 5 × 2 ins. × 5 ft. are attached to the lugs on the lower end of the ladder with 2-in. steel pins; the top of the bars are bored out to take 2½-in. ends of a 7 × 2½ in. crossbar, 4 ft. over all.

A quadruple sheave, 20 ins. in diameter, is attached with two straps to the center of this crossbar, and a corresponding sheave is built into the top of the gantry. Three of the sheaves are carried between ⅜-in. steel plate rivetted across the top of the gantry and secured with 3 × 3 × ⅜ in. angles. A cast steel pin 2½ ins. in diameter passes through the whole, and the wheels are made to turn on the pin. The fourth sheave is hung separately in a strong 1½-in. diameter shackle, the ladder line is reaved through these pulleys and attached to the winch, with which the ladder is raised and lowered.

THE BUCKETS.—The principal feature of a bucket is that the mouth should be wide and the back shallow, the object being that the material when dredged may fall more readily when the point of discharge is reached.

Buckets are made from 3 to 12 cu. ft. capacity. Except in special cases, a large bucket does not appear to be a distinct advantage, when the difficulty of handling plant, with its additional outlay for repairs and renewals, and washing the quantity of material raised, as well as the extra cost of equipment, are taken into consideration. The buckets in general use under most conditions are of 4½ cu. ft. capacity, and are constructed as follows: The body is of 5/16-in. steel plate, and the bottom or apron plate of ½-in. steel. Doubling plates 10 ins. wide are rivetted along the sides, and a bar 2 × ½ in. is rivetted across the front of the apron plate.

The links are of cast steel, of the same quality as is used for railway tires, 5 × 1½ ins. at the ends and drawn down to an inch at the center; these are rivetted to the buckets with 1-in. steel rivets. (It is advisable in boring for rivets that each link should be interchangeable and reversible.)

After the links are rivetted on, the buckets are bored out to receive manganese steel bushes ⅝ in. thick; the internal diameter after bushing varies from 1⅝ ins. to 2⅛ ins. to take 1½-in. to 2⅛-in. pins. Buckets are lipped with spring or cast-steel lips 6 ins. wide from ⅛ in. to 1 in. in thickness, the thickness varying with the class of ground to be worked. The connecting links are made of tire steel 5 × 2 ins., bored and bushed the same as the bucket links.

Care must be taken to drive the bushes in as tightly as possible so that they cannot turn, and as soon as the bushes are worn they must be replaced. A bucket or

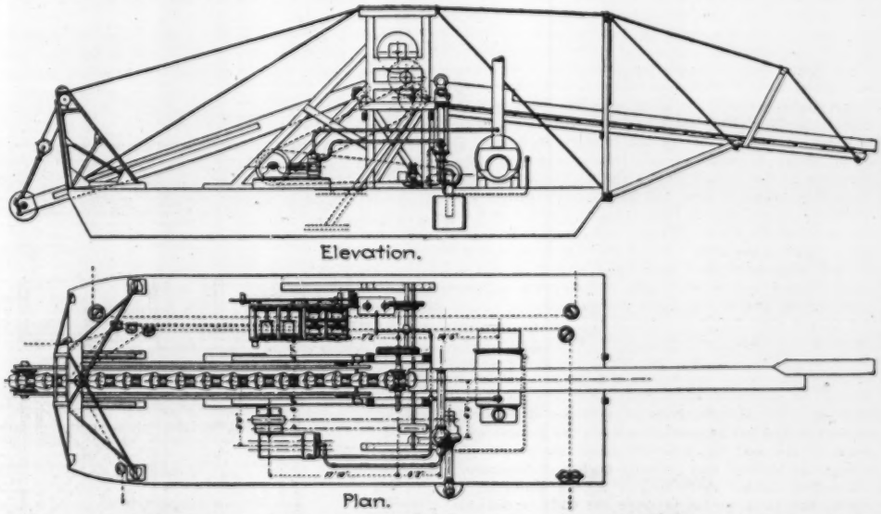



FIG. 4. PLANS SHOWING ARRANGEMENT OF DREDGING MACHINERY ON PONTOON SHOWN BY FIG. 3.

*For a similar plant with tailings elevator, the cost would be approximately, $5,000 more.

link can easily be destroyed by the pins wearing through the bush into the eye of the link. Pins connecting the links and buckets are of tempered cast-steel. We have tried various makes of steel for these pins, but find that there are none that stand the wear like those manufactured by Hadfield, of Sheffield, from their manganese steel, of which material the bushes should also be made.

We are of the opinion that a bucket constructed with the wedge-shaped link, which naturally tilts it at a higher angle than the line of the ladder, is an improvement, for the reason that when the point of discharge is reached the radius of discharge is increased. This gives the bucket a better chance to empty, should the material being worked at any time tend to a puggy nature, and not readily leave the bucket. The buckets and links described form an intermittent chain, which commends itself, as the buckets can be run faster and will handle large boulders and logs. The close chain of buckets, in which they follow one after another with no connecting link in between, should be of advantage in loose, free-running wash, but would be detrimental to satisfactory results when working hard or cemented ground and in dealing with timber and boulders.

TOP TUMBLER.—This tumbler is four-faced, and turns the buckets. It consists of two hard-cast steel checks, bored out and fitted to a steel shaft with two keyways sunk at each end and placed at right angles to one another. To save wear and tear top tumblers are sometimes made with 4-in. steel angles let into the corners of the cheeks, or steel plates are studded on to the faces and renewed as worn out.

The width of the faces of this tumbler is determined by the maximum angle at which the ladder is intended to work. The faces should be as wide as possible to save slipping. The shaft on which the tumbler is keyed is 8 ins. in diameter, reduced at the ends to 7 ins. These ends rest in cast-iron bearings, brass bushed on the bottom side and cast-iron top bushes. The bearings rest on sole plates which have strong ribs cast on to the bottom, to let into the timber of the tumbler framing, and the whole is held in position with six 1⅛-in. bolts for each bearing.

DRIVING GEAR.—The driving gear consists of a 72-in. spur wheel with an 18-in. pinion and a 60-in. spur wheel with a 12-in. pinion. The 72-in. or crown wheel is 8 ins. wide on the face of the tooth and 4-in. pitch. This wheel is keyed to the end of the top tumbler shaft, and the 18-in. pinion is made to suit this spur wheel and is keyed on to the second motion shaft. The 60-in. wheel has a 6-in. width of face, and 2½-in. pitch, and is fitted on to the second motion shaft; to this wheel a cast-iron friction drum 36 ins. in diameter and 5 ins. wide is fitted and secured to the arms. The drum is fitted with a steel friction strap lined with wood, and with right and left square-thread screws with nuts, levers, arms and cast-iron sleeves, and a large lever for working.

A forged steel driver is fitted to the friction strap and keyed to a turned steel shaft 5 ins. in diameter and 11 ft. long. This shaft has two loose collars and runs in cast-iron bearings, brass bushed and lying on sole plates, resting on an outer horse and inside on the tumbler framing. The friction drum is used for throwing the buckets in and out of gear; also when the buckets are at work, if the load becomes too great, the clutch slips, arrests the buckets, and prevents mishap or breakage.

The first motion shaft is 3 5/16 ins. in diameter, and carries the 12-in. pinion to drive the 60-in. spur wheel. On this shafting is also placed a 4-ft. pulley 13 ins. wide, connected by belt with the main engine, and two eccentrics to drive the air and feed pumps.

WINCHES.—A dredge winch has, as a rule, a surging drum and six barrels, each of which can be operated separately; one of these carries the ladder line for raising and lowering the ladder, another the head line which keeps the dredge up to the face and its work. The four remaining barrels hold side lines, one each at the bow and stern on either side. A seventh barrel is useful for general lifting purposes and for working a crane for dealing with timber dredged up.

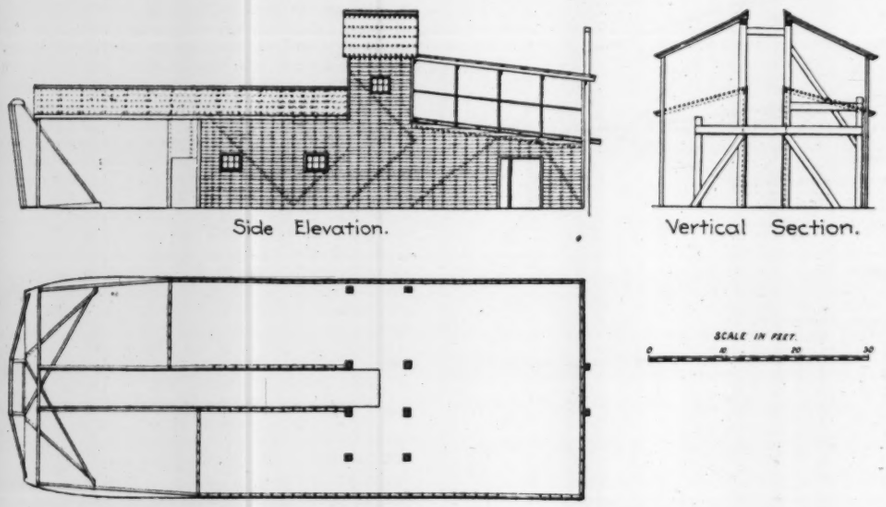



FIG. 5. PLANS SHOWING HOUSING FOR DREDGE SHOWN BY FIG. 4.

The surging drum is used in connection with the pulley placed on the second motion shaft for reversing the buckets, which is at times necessary, especially when the main engine is not reversible. These winches are operated on by a pair of double 4½-in. cylinder Marshall engines, and are constructed as follows: The seven barrels and surging drums are fixed in series to a frame constructed of ⅜-in. steel plate, 17 ft. long and 18 ins. high, in the manner as shown in Fig. 2. The winches are constructed so that the barrels can be worked separately or altogether, except in the case of the side and stern line barrels, of which only the two on either side can be worked together, which is all that is necessary.

Each barrel is cast with flanges 5 ins. deep, on which, on one side, a ratchet and brake drum are cast. A pawl to work each ratchet is fixed to the winch frame. The brake drum is turned true and fitted with a wood lined strap applied with a screw (square threaded), and a hand wheel. This brake keeps the barrel firm and immovable when the drum is out of gear. On the other side of the barrel a clutch is cast. The drums are bored out and fitted to 4½-in. turned steel shafts, reduced at the end to 4 ins. and running in 4-in. solid cast-iron bearings, bolted to the frame of the winch.

This shaft is fitted with a cast-steel clutch sliding on two sunk feathers in the shaft. The clutch is worked by levers into the barrel clutch. The bow and stern line barrels are placed in pairs, the bow lines on one shaft and the stern on another, one double clutch and lever works between these barrels, and is pushed into either as the case may be.

Power is conveyed to the winch along the shaft that runs for the full length of the winch at the back, being connected by a wheel and a pinion, keyed to the crank shaft of the engine. Two levers connect with two pan friction clutches; one, with suitable gearing as shown, brings the three forward barrels and surging drum into action, and the other the bow and stern line barrels. On the center of the winch in the front there is also a lever by which the engine can be reversed; holes are bored in each barrel in which a clamp holds the end of the wire rope. A rod of ¾-in gas pipe runs through of the winch, and is fitted with four light hand wheels. The end is attached to the stop valve of the engine and enables the winchman to regulate the steam from any position along the winch. A depression roller is fixed to the deck under each barrel for keeping the lines clear.

The winches as shown on Fig. 7 are of different construction, as will be noted. They are worked by wood friction drums working inside the winch barrels; the levers in front of each winch barrel push the friction drum by means of a steel stop into the barrel, when it is required to be used. This type of winch is much lighter and is very easily worked, but it is not suited to heavy ground.

The mooring lines vary in size, from ⅝ in. to ¾ in. in diameter, with the class of ground to be worked; the ladder line and head line should never be less than ¾ in. in diameter.

BOILER.—Any type of boiler, provided that it does not take up too much room, may be used on a dredge. The "Marshall Dredger" boiler, of well-known design, is largely in demand for this class of work in Australasia. The boiler that can be recommended is of the return tube marine type, with internal flue, working up to 120 lbs. per sq. in. This boiler can be 6 ft. 6 ins. in diameter and 8 ft. long (12 ft. over all, with combustion chamber and smoke box) fitted with 48 tubes, 3 ins. external diameter and will give 75 I. HP.

ENGINE.—The engine requires no special comment. A "Marshall" type is in general use, of from 16 to 25 HP. nominal. The engine used on the plant being described is 16 HP., making 125 revolutions per minute; it has compound cylinders 8 × 14½ ins. and 14 × 14½ ins. On one side are a 4-ft. pulley, 13 ins. face, and a flywheel, 4 ft. 9 ins. in diameter, 10-in. face. A belt from the flywheel connects with the first motion shaft, and the pulley works a 12-in. centrifugal pump.

CONDENSER.—The condenser is 7 ft. long, the over tube plates 24 ins. in diameter, and is made of ¼-in. steel plates. Tube plates are ⅝ in. steel, and rivetted to the barrel by 3 × ⅜ in. angle steel; there are 19 3¼-in. diameter tubes expanded into the tube plates, the ends being of cast-iron, secured by studs tapped into the tube plates and angle iron.

It will be noted that in a dredge condenser, boiler tubes are substituted for the ordinary brass condenser tubes, the reason being that the water pumped from the paddock to the boxes by the 12-in. centrifugal pump all has to pass through this condenser, and is always dirty and contains chips, weeds, etc.; larger tubes must in consequence be used to prevent their becoming choked.

The end castings are faced for jointing to the water pipes from the centrifugal pump; the lower casting has a hand hole with a door for cleaning purposes, a connection for a 3-in. pipe, and four snugs for bolting up to the deck.

Two cast-iron seats are riveted to the body of the condenser, made with slots for bolts, and are faced for the pipe connections, and a bracket is rivetted to it for securing the lower end of the water feed heater.

The water feed heater is of cast-iron of dimensions 5 ft. 9½ ins. long, 11⅜ ins. outside diameter and 9⅝ ins. inside diameter; the internal coil is 1¾ in. diameter copper pipe of 12 gage, and is fitted inside the casting with one connection at the lower end and one at the side.

AIR AND FEED PUMPS.—These pumps require no special comment. A hot well is, however, fitted to the discharge of the air pump, and connected with the suc-

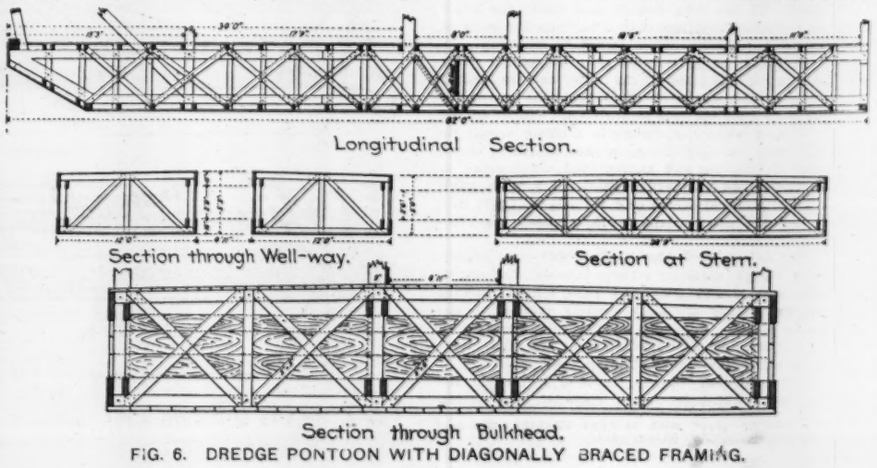



FIG. 6. DREDGE PONTOON WITH DIAGONALLY BRACED FRAMING.

tion pipe of the feed pump; these pumps are worked off the first motion shaft by two eccentrics. The feed pump is screwed down on to the sole plate of the air pump with studs, the sole plate being faced to receive it.

WATER PUMP.—A 12-in. centrifugal pump fitted with two standards and one 18-in. pulley driven off the main engine supplies the water to the dredge; any well-known make is suitable. The piping used is as follows: The intake is a tapered casting 18 ins. long, 14 ins. reduced to 12 ins. inside diameter, and ⅝ in. thick, with a flange 3½ ins. at the larger end, and a ¾-in. flange at the smaller end fitted with a loose revolving ring in two halves. This casting is fitted to the pontoon through the side bolted to it, the joint being watertight.

There is a grating of ¼-in. round iron bars, covered with wire netting, fitted into a bevel box, bolted on to the outside of the pontoon over the intake.

A flanged pipe, 12 ins. in diameter, of 13 gage steel plate with a 12-in. cast-iron bend, connects the intake with the pump; a 12-in. flange pipe of 10 gage steel leads from the pump delivery with a 12-in. cast-iron bend, ⅝ in. thick, to the condenser; a 12-in. flanged pipe bolts onto the top of the condenser with a cast-iron reducing bend on the top, reduced from 12 ins. to 11 ins. This bend has a branch connection for a 3-in. pipe, and a pipe, 11 ins., 12 gage, carries the water to the sluice box, being directed into it vertically by an 11-in. bend. The 3-in. connection referred to takes water in the 3-in. pipe to the drop plate below the bucket discharge.

When a revolving screen is used the arrangement is slightly different. The 11-in. pipe on the top of the condenser is fitted with an 11-in. bend, and an 11-in. pipe is run aft to the lower end of the screen and is connected by a bend and T-piece, reduced from 11 ins. to 9 ins., with a perforated pipe running up the inside of the screen. A sluice valve on a connection from the T-piece regulates the water to the sluice run.

LIGHTING PLANT.—Oil lamps, acetylene gas and electric lights are used for lighting dredges; but an electric installation is the best, which should be of sufficient power to generate 25 16 c. p. incandescent lamps. The dynamo should be driven with an independent engine and all lights should be hung free with flexible wires to counteract vibration.

All dredges are built on these general lines as far as the machinery above described is concerned, but naturally vary somewhat in design according to circumstances.

The appliances used for the treatment of the material dredged, which distinguish the two types of dredges previously referred to are: (a) the screen and elevator, etc.; (b) the sluice box. It is proposed to describe them in the order named.

THE SCREEN AND ELEVATOR, ETC.—The screen constructed as follows is a good example of this appliance. It is 17 ft. over all and 54 ins. diameter outside. Two end plates of ⅛-in. steel, 24 ins. and 36 ins. wide, carry the gear, these two plates forming the outer ring.

The intermediate rings run as follows: The uppermost one is 5/16-in. plate, 36 ins. wide, perforated by 5/16-in. holes, 1¼-in. centers. The second ring is ⅜-in. plate, 36 ins. wide, ⅜-in. perforations, 1½-in. centers. The next is ⅜-in. plate, 36 ins. wide, 7/16-in. holes, 1⅝-in. centers; and the fourth ring is ⅜-in. plate, ½-in. perforations, 1-in centers. These rings are jointed with steel butt-straps, 4½ × ½ in., in longitudinal and circumferential seams, the rivets being deeply countersunk on the inside. To the upper and lower edges rings of angle steel, 2½ × 5/16 in. are rivetted.

On the lower end plate a 72-in shell wheel and roller path in one casting is fitted. This shell wheel, with the aid of a suitable pinion, turns the screen. The general driving arrangement is shown on Fig. 2.

On the upper end plate a roller path of cast-iron 8 ins. wide and 2 ins. thick is rivetted to the screen with countersunk rivets on either side. These roller paths revolve on four rollers 18 ins. in diameter and 8 ins. wide, two on either side. The screen is set on these rollers with a pitch aft of 1 in. to the foot.

Water is supplied by means of a 9-in. pipe, which enters the lower end of the screen and runs for its full length. This pipe is connected with the water main and is perforated for 12 ft. opposite the perforated rings of the screen with four rows of ½-in. holes at 4-in centers.

At the top end a drop plate is hung in the tumbler frame below the top tumbler and enters the upper end of the screen; this drop plate is semi-circular in shape, of ½-in. steel plate, and the bottom is lined to take the wear, with 3 × 2 in. steel bars rivetted on.

The finer material being treated is washed through the screen perforations on to the gold-saving tables running athwartships. These tables are 14 ft. long and 12 ft. wide, made in four widths of 3 ft. each, stepped one above the other, with division plates between them. They are constructed of 8-gage steel plates joined by 2 × 2 × ¼-in. angles; the outer sideplates are 8 ins. deep, and have bars 1¼ × ¼ in. rivetted along the upper edges.

The inner division plates are 12 ins. deep, and short pieces of angle iron 4 ins. long, 2 × 2 × ¼ in. are rivetted on the side plates from which the mats are wedged down. All the division plates have a segment cut out at the top end for clearing the screen when revolving.

The back plate to the tables is 30 ins. high, and inside this a box 8 ins. wide runs the full width, from which a sliding door to each division in the tables regulates a flow of water; a 4-in. pipe from the water main supplies this box.

The pitch of the tables is usually about 1 in 10. The tables empty into a semi-circular chute 45 ft. long, 20 ins. wide and 10 ins. deep, of 10-gage steel plate; this shute runs out over the stern of the dredge; to take the wear it is lined with 3/16-in. plates. The tables are covered first with calico on which is placed cocoanut matting, over which are placed strips of expanded metal which act as a ripple. The calicoes, mats and expanded metal are wedged tightly down by means of the angle iron cleats.

The screen discharges into a tail chute of a similar construction to the drop plate, and is made of ⅛-in. steel plate lined with 3 × ⅜ in. steel bars curved to fit the screen. The tail chute empties according to the arrangements used, (a) into a sluice box, or (b) into the trays of a tailings elevator. Detail's of these alternate arrangements are as follows:

THE SLUICE BOX.—The sluice box is 24 ft. long, 3 ft. wide and 18 ins. deep, and can be made of steel plates 3/16 in.; the bottom and sides are secured together with 2 × 2 × ¼ in. steel angles rivetted on the inside and stiffened along the top edges by 1½ × 1½ × ¼ in. angles rivetted along them. The box is fitted with ripples overlying cocoanut matting, the latter superimposed on calico covering the bottom of the box; the pitch of this box varies from 1 in 7 to 1 in 9, according to circumstances. The gold that has not passed through the screen perforation on to the gold-saving table is here saved.

By arranging that the semi-circular chute shall protrude further astern than the end of the sluice box, all the finer material can be deposited on the surface of the ground after dredging, which point has sometimes to be taken into consideration when valuable agricultural flats are being worked.

ELEVATOR.—The material passing from the screen tail shute to the trays or buckets of the elevator is conducted astern without further treatment for gold, and is deposited at sufficient distance and height astern for stacking purposes. The height to which the tailings have to be stacked will determine the length of the elevator.

The following design, as shown in Figs. 8 and 9, is a good example of an elevator. It has 30-ft. centers of tumblers and 27 ft. 10 ins. centers of pivoting shaft and top tumbler. The ladder is built of steel framing, braced and formed as shown. All the fittings and parts are illustrated in detail, and these with the trays depicted in Fig. 10 are all carried on the ladder.

It will be noted that a platform with hand rail is arranged around the ladder to enable the workmen to get at any part while the elevator is at work. The pivoting shaft is carried on to cast-iron brackets resting on a frame built out at the stern of the dredge, on which the bottom tumbler also works. The steel trough shown is to take all leakage from the buckets to the bottom of the elevator and into the paddock.

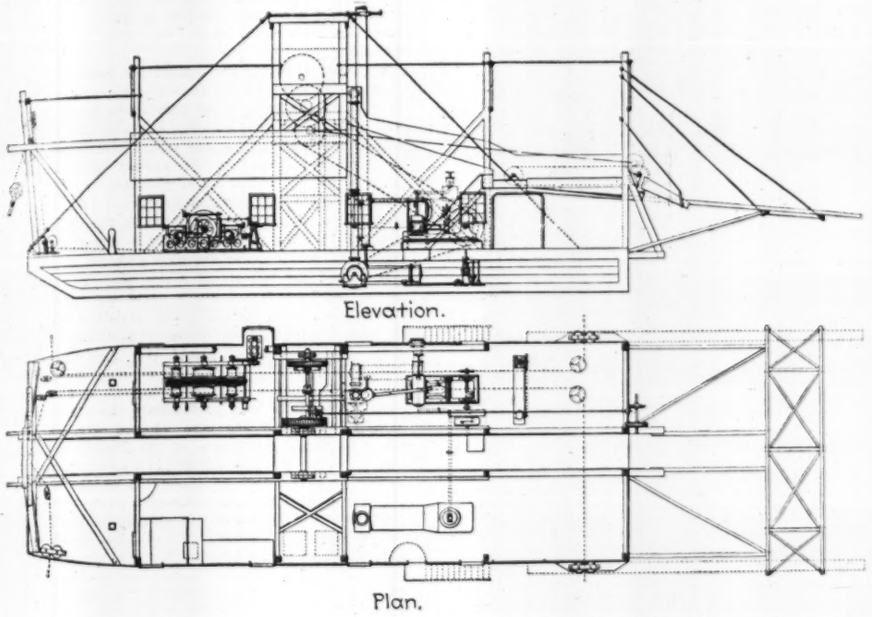



FIG. 7. PLANS SHOWING ARRANGEMENT OF DREDGING MACHINERY ON PONTOON SHOWN BY FIG. 6.

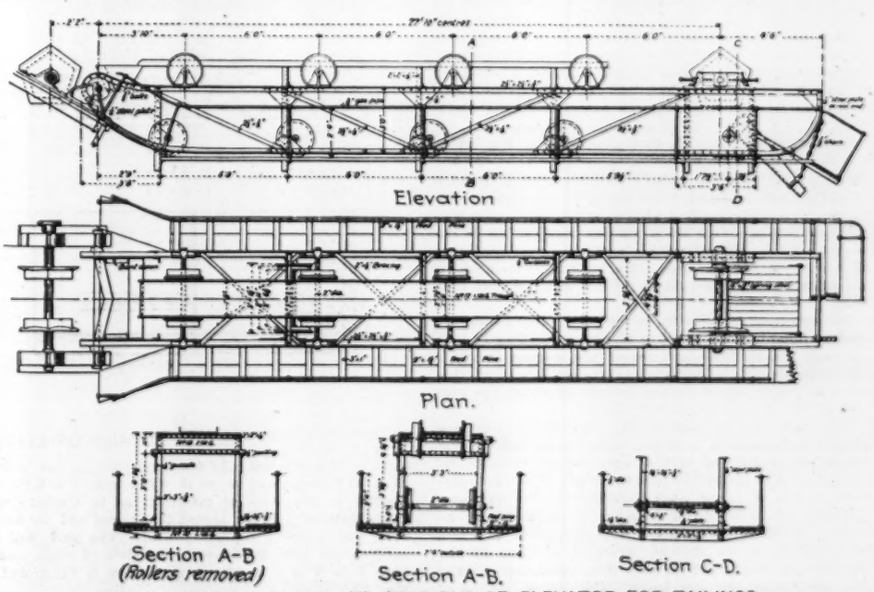



FIG. 8. GENERAL PLANS AND SECTIONS OF ELEVATOR FOR TAILINGS.

The bucket belt is driven by the bottom tumbler and is supported on the top track supporting rollers, four in number, to the top tumbler, and is returned from the top to the bottom tumbler supported on four bottom track rollers. The details of the bucket will be noted in Fig. 10, from which it will be seen that the links on each alternate bucket are male and female; the chain when put together follows on, one fitting into the other. One

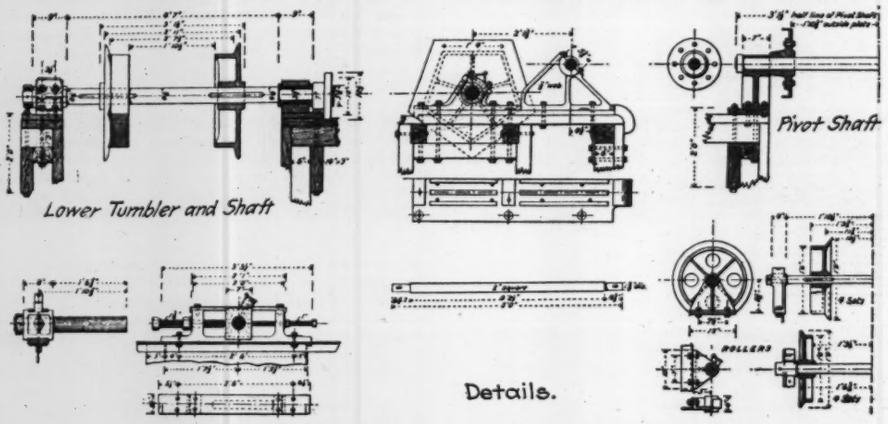



FIG. 9. DETAILS OF TAILINGS ELEVATOR SHOWN IN FIG. 8.

bucket is made with one end male and the other female. This bucket, called the hunting bucket, is used to couple up the chain and close the belt.

The buckets are set well forward on the links to allow good delivery over the back of the one in front.

The elevator should be driven either by a belt or a friction clutch to admit slipping should anything happen to increase the load over 50% beyond the working load, and thus avoid heavy breakage. The speed at which elevator buckets travel is from 30 to 40 ft. per minute. All pins and bushes in the links should be of manganese steel.

When erected the elevator hangs at an angle of from 25° to 40° from the horizontal. An angle of 30° is found the most suitable working angle.

For stays for swinging the elevator we find it preferable to use rods of iron, which, by welding, can be lengthened or shortened in a few minutes to the required length, and, unlike wire guy ropes, do not stretch when once adjusted to the right length.

The combination of screen and sluice box is used when coarse, nuggety gold occurs. The arrangement can be altered when an elevator is required for stacking the tailings, by placing the sluice box below the drop-plate, the screen following on to discharge into an elevator.

To use a screen the material to be treated must be free-wash, otherwise it does not have time to get washed if an elevator is used. A large percentage of the gold under these circumstances would be lost. Should, at times, the material being treated incline to a clayey nature, retarders in the form of angle irons are rivetted to the inside of the screen.

SILT ELEVATOR.—There are cases in which ground has to be dredged containing a very large proportion of light, running sand, which it would be impossible to work unless some means was provided to deliver it into the trays of the tailings elevator in a dry state for stacking purposes. The sand, when run through a chute or sluice box, will not stack but runs back into the paddock, and when it is present in large quantities would block operations by the dredge getting aground astern.

In our opinion, the silt elevator shown in Fig. 11 is the best that has been applied to dredging. It was designed by Mr. Herbert Park, a civil engineer of Sydney, N. S. W., and is amply explained and illustrated in the drawing. A small chain of buckets of 2½ cu. ft. capacity, with connecting links, all of similar construction to the buckets previously described, work over the tumblers shown in an endless chain, the bottom tumbler being placed in a sump hole built in the hull of the dredge pontoon.

The principal features in this elevator are: First, the buckets must be kept small to ensure overloading so that no water can be lifted; and second, the manner in which the sand or silt is delivered to the buckets, and this plan, although simple, is the feature on which the success of the contrivance depends solely.

The sand, having passed from the screen over the tables, is brought in a return table to the side of the sump, and discharged into a compartment which is divided from the central portion by means of a board partition which is raised above the surface of the water and goes only to within 12 or 18 ins. of the bottom of the sump. The sand falling into this compartment, into still water, sinks to the bottom, where it is lifted by the buckets and discharged on to a drop plate that empties into the tailings elevator trays. The central portion of the sump, while the buckets are at work, is always in a state of agitation, which condition would not allow the sand to settle.

With this elevator the sand is delivered at the stern, drained of all water, and will stack at an angle of 45°. This elevator is driven by an independent 10-HP. engine.

The objection to this elevator is that it occupies a good deal of space, is very heavy, and the wear and tear great on the tumblers, links, bushes and pins. It is, however, surprising to find that silt in a very fine state of division with the arrangement described will settle immediately, and is lifted free of water. The overflow from the sump is conducted astern in a launder.

We have lately seen in "The Papers and Reports relating to Minerals and Mining," of 1905, published by the New Zealand Government, a description of an elevator for dealing with fine sands as designated by Edward Roberts, C. E., Dunedin. Mr. Roberts' arrangement appears much lighter, would occupy less space, and there should be little or no wear and tear. It will be interesting to learn of the success of this design after continual working.

TREATMENT BY SLUICE BOX.—In the treatment of the wash by this method, a drop plate is either, as in the case of the screen arrangement, hung in the tumbler frame, or else built into it in the manner shown in Fig. 4. This drop plate discharges into a long sluice run which runs aft for the length of the dredge and over the stern. The length of the box will depend on the position of the tumbler framing, and the height to which the material is to be stacked. As a general rule the box is from 40 to 50 ft. long, and varies in width from 3 to 6 ft., according to the class of materials to be treated; with sandy material a bigger spread is required and the box is wide, and inversely for heavy wash. The pitch will depend on the same difference in the class of wash, and is from 1 in 8 to 1 in 10. A sluice box is illustrated in Fig. 12.

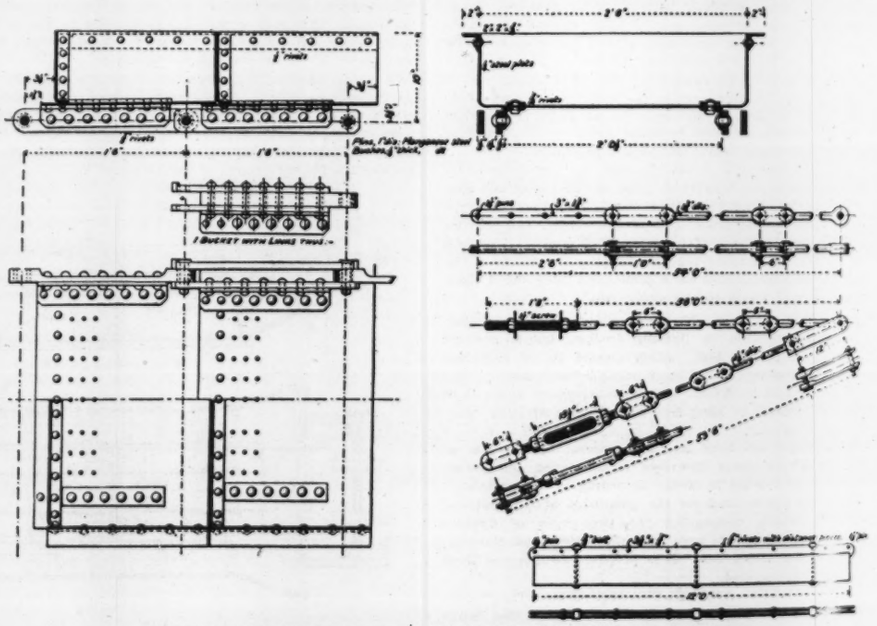


FIG. 10. DETAILS OF ELEVATOR BUCKET AND CONNECTIONS.

The bottom of the box is laid with perfo[rated] plates and ripples for its entire length, the ripple[s] overlying the cocoanut matting and calico. In laying [the] ripples it is found advantageous to use as ma[ny] different classes of ripples as possible, by which mean[s the] ripple in the water as it flows down the box is altere[d] and consequently, the material being treated is tosse[d] about, its course altered, and the gold which may be [in] bring to the stones or grit has more chance of being l[iber]ated.

The classes of ripples used are angle irons, [per]forated plates, and crimped or diamond-[mesh]; the latter are only used when very free wash[ing] being dredged.

A ripple, while in work, must not become [lo]cked or choked, but must always remain open so that [the] gold, as it is caught, will fall at once on to the m[at]. As is well known, ripples of different makes act diffe[r]ently with various material, so that one should always us[e the] class of ripple best suited to the ground being w[or]ked, in order to get the maximum of efficiency.

A return box is sometimes used fitted as sho[wn] in the illustration. An opening is made in the bott[om] of the box over which a perforated plate is placed, an[d] all material that passes under the plate goes out by [the] return box behind the tail of the sluice run. The return box serves two purposes; it either saves any light gold that has traveled down the sluice box, or else it may be used to take a portion of the water from falling on the tailings. Expanded metal placed over matting and calico collects any gold.

In dealing with a large percentage of sand or fine material in a sluice run, to facilitate the stacking of the tailings a method has been adopted with success, by which a large percentage of the fines are conducted further astern than the coarse and heavier material. The device is constructed as illustrated at the end of the sluice run on Fig. 4, by reference to which it will be noted that a small shute runs alongside the main box for a few feet at its lower end and protrudes beyond the end of the box. An opening is made in the side of the main box leading into this shut, and a portion of the finer material and water is passed into it as follows:

In the main box a run of 6 or 8 ft. of perforated plates are laid above the opening in the side and coming down to the end of it. On the last perforated plate an angle iron is rivetted diagonally across it and run across the box to the end of the side opening. This blocks all fine sand and water that has passed under the plates and directs it into the shute to be deposited astern.

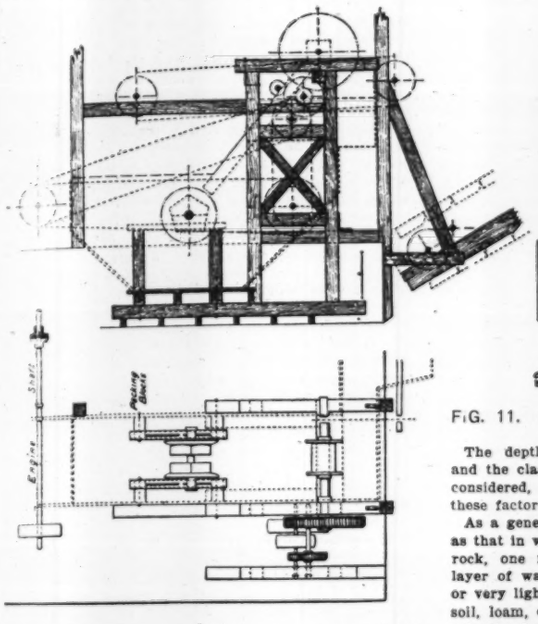
Under the above headings the main treatment of a material dredged has been outlined. As the buckets in passing over the top tumbler do not deliver all their material on to the drop plate, every dredge should be supplied with a "Save-all," which is merely a sluice box arrangement to catch any material and drippings from the buckets which is not discharged on to the drop plate. Two methods of arranging the "Save-all" are shown in Figs. 1 and 3. A set of grizzly bars are hung under the drop plate to within 4 ft. of the deck. At the back of these bars a sluice run from 15 to 20 ins. wide runs to and over the stern of the dredge.

The "Save-all" is of great advantage in dredging shallow ground, as there is always a quantity of material falling into the well-way when the stuff tips late; and if the "Save-all" were not in use the late-tipping material might

fill up the well-way and get the dredge aground. A considerable quantity of gold is saved weekly by this arrangement at no extra cost.

ALLUVIAL DEPOSITS SUITED TO BUCKET DREDGING AND THE REQUISITE CONDITIONS FOR SUCCESSFUL OPERATIONS.

The suitability of an area for dredging purposes must first be determined, and then, a most important and essential point, the style of plant most suitable for the particular area designed.



There are two classes of dredging areas, which might be described as the "river dredging area" and the "paddock dredging area," respectively. The former consists of a flowing river covering the major portion of the area, which type of dredging ground lends itself to successful operations, and the equipment of such areas presents no difficulty to the engineer.

Paddock dredging is a term that has been applied to operations on the so-called rivers and creeks, which consist for the most part of small running streams with stretches of alluvial flats of varying width along their course, and to terrace ground to which water is supplied by a head-race or by means of a pump. It is to this class of ground, which is that mostly met with, that these notes chiefly refer.

Given an area on which it is proposed to work a dredge, the first things to be studied are the facilities that offer themselves for successful operations, the value of the material to be dredged, and then the most suitable plant for the class of ground.

What might be termed an ideal dredging area would be one that could be successfully worked by the simplest class of plant, viz., the sluice box type of dredge, and which displays the following features:

(1) A long length of area, free from rocky bars, and of fair width.

(2) A good water supply.

(3) A loose, shingle wash, free from cement or clay.

(4) The absence of large boulders or sunken timber.

(5) The bottom or bedrock being soft and easily worked by the buckets.

(6) The ground not being too deep, and all below water (an average of 20 ft. is a good dredging depth).

It is considered better to find a little gold all through the material to be dredged, when examining an area, than to have it all on the bottom, as the former condition will give steadier yields.

As one seldom finds ideal areas, it is a question, when inspecting dredging ground, of deciding if it is possible to get over difficulties arising from poor facilities, or conditions, in the way of successful operations. In judging these matters no arbitrary rule can be laid down, but one must be guided largely by experience and knowledge of what a dredge can do.

A good-sized area is necessary to give sufficient life to the enterprise, as under favorable circumstances, with a dredge of 4½ cu. ft. bucket capacity, on the average, an acre a month would be worked; this, of course, depending on the depth to bedrock and the class of material to be treated.

Ridges of rocks across an area to be dredged, and over which the dredge must pass, are not uncommon. When this is the case, there must be facilities for dam building in order to float the dredge over the obstacle. If the expense is not too great, blasting may at times be resorted to.

To do good work, a dredge requires a wide face to operate upon; narrow ground necessitates much shifting of lines, and entails loss of time through having to take out corners. A dredge cannot work in a paddock narrower than its length, as there must be sufficient room to allow it to swing right round.

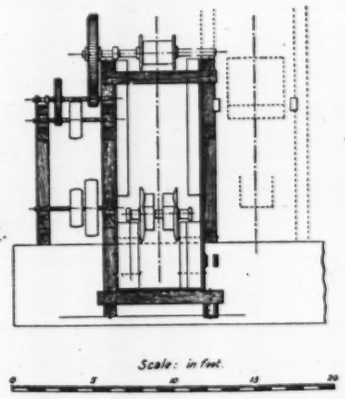



FIG. 11. GENERAL PLAN OF SILT ELEVATOR.

The depth of ground above and below water-level, and the class of material that has to be lifted, must be considered, as the design of plant depends largely on these factors.

As a general statement dredging ground can be classed as that in which one finds, first, from grass roots to bedrock, one mass of stony gravel wash, and second, a layer of wash on the bottom over which may lie sand, or very light drift, or alternate beds of clay, sand, black soil, loam, etc.

In the first case, when one only has a gravel or wash to deal with, if the bedrock is soft and there is an efficient water supply available, the proposition offers no difficulties; but when there are other materials to be dealt with such as are above enumerated, it becomes a matter of study as to whether they can be successfully handled.

The objection to dealing with clay in thick beds is, that it is very slow working when the buckets are filled with it; it is frequently found that they will revolve without emptying, and when they do empty, it is in compact, bucket-shaped masses, which are apt to pile up on the drop plate, where there is not sufficient water to carry them away, and the buckets have to be stopped, the accumulation cut up by hand, and washed away in small pieces.

A clayey adhesive wash is detrimental for the reason that there is not time for it to be washed clean and the gold liberated, either by treatment in a sluice run or revolving screen. Such classes of wash require puddling, a process too slow for the treatment of the quantity of material raised by a dredge. However, ground containing clayey wash and clay over-burden is made to pay where it is rich in precious metal, but the percentage of gold won is small.

Bands of cement of any thickness are practically prohibitive for dredging, although we have experience of one case where a dredge worked ground 35 ft. deep in which there was a band of very hard cement lying some distance below the surface, with free wash above and below it. The wash was dredged below the cement, which remained protruding from the face, after which the ladder was raised and the buckets kept tearing at the cement, and in time it was broken up, but at great cost for wear and tear, as buckets were destroyed continually and links and pins broken. The area was, we believe, rich, but it is very doubtful if this class of ground paid to work. Figures of working costs are not obtainable, and we are inclined to believe that all profit, over and above actual working expenses, would be absorbed by renewals to plant, which were frequent.

Sand occurring in thick beds is difficult at times to deal with, unless special means are adopted by the use of the sand elevator as described. This only applies to paddock dredging where the tailings have no get-away, as in the case of a river.

The presence of large boulders and loose masses of rocks do not necessarily hinder operations, unless they occur in nests or patches, under which circumstances the ground may be passed over without working the bottom, floating room only being taken by the dredge. Sunken logs and trees in the ground, if they do not occur in too great an abundance, are not a bar to successful operations, but then special means have to be provided for dealing with them in the shape of a mast and derrick for raising the logs. We have had to deal with trees 60 ft. in length, with 5 ft. butts, lying 15 to 20 ft. below the surface.

The bedrock or bottom on which the buckets work must be soft to insure best yields, for while the plant is at work the bulk of the gold puddles down, and if the buckets cannot scrape the bottom there is great loss.

In a country where the rivers and creeks are dry or nearly so in summer time, the question of obtaining sufficient water is often of moment. As can well be understood, the more water available the better, but it requires very little added water to keep going when a dredge paddock is full, sufficient only to replenish soakage through the drifts and loss by evaporation being necessary.

At times there is no available water running on an area, in which case a supply may be obtained from the surrounding country by gravitation. There are cases where a flat above a river level has been worked, the water supply being obtained by pumping. This was done by the authors in one case, using a No. 7 pulsometer, pumping water up to 20 ft. to the paddock. A supply of 120,000 gals. in the 24 hours was found sufficient.

Although one can work with a very limited supply of water, there is always the drawback that the water in the paddock becomes dirty and thick, and this may cause loss of very fine gold.

To determine dredging facilities, the foregoing conditions have been pointed out as a guide as to where difficulties may be found, but we wish it to be understood that they may or may not, according to circumstances, be overcome, and the statements are not to be taken as conclusive in any case.

Having satisfied one's self that the local conditions and class of ground to be dredged are satisfactory, the matter of gold contents should then be studied and ascertained.

It is a difficult matter without going to great expense to get at the actual average value of dredging areas.

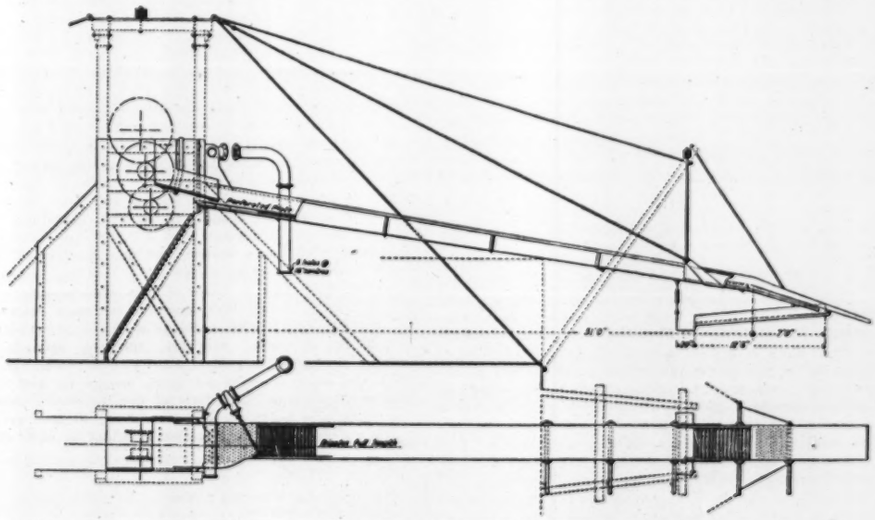


FIG. 12. GENERAL DETAILS OF SLUICE BOX CONSTRUCTION.

One must be guided by experience in judging prospecting results before deciding to equip any area.

Dredging will always pay on old abandoned diggings, that is to say, on any old alluvial goldfield where the working conditions are suited to dredging, and where gold has been won in the past from the beds of a river or creek and adjacent flats. Notwithstanding the ground having been turned over, the old miners will invariably have left enough behind to allow a dredge of reasonable size and power to go over the ground once again at a profit. This might almost be accepted as a "rule." As evidence of this rule, so termed, one only has to ascertain where the most successful dredges are working in New Zealand and Australia.

We equipped an area with a 4½ cu. ft. bucket dredge at Klandra, New South Wales. The ground was known to have been turned over at least three times by Europeans and then by Chinese in the last 40 years, but notwithstanding this fact, the dredge paid well.

The old miners in the past usually worked by paddocking, using wheels and pumps, and leaving pillars of solid ground between each paddock; they were not able to work the deeper channels to advantage, so that on all these old fields, sufficient gold has been left behind to give payable returns to a dredge.

An old goldfield, therefore, need not be systematically prospected, and can be taken for granted as payable. The ground has only to be bored to ascertain the depth to bedrock, and if it is hard or soft.

It has been found useful to make a series of tests by dish-panning the surface wash over extended areas; by this the presence of gold can be detected, but the results are of no practical value, as, in panning prospects from river beaches, it is generally found that local concentration occurs, especially after floods, and this might be, and has been to some, very misleading.

The material taken out with bores may be washed and the gold contents ascertained. The method of boring, being well known, requires no special comment, but it may be stated that the authors have not found it their experience that the results obtained from bore-holes are very reliable. There are conditions when boring is the only test that it is possible to adopt. It is however, considered best, where possible, to sink a series of shafts on an area, and to cradle all wash and material taken out, collecting and weighing the gold obtained.

In this manner a definite number of cubic yards are treated, and, without taking into account finer calculations, the result should, in consequence, be more practical. Where water has given difficulty in sinking, a portable boiler with a steam pump of the Worthington type has been used with success. The boiler is easily moved from station to station, and the pump can be conveniently swung in the shaft with chain blocks.

A method that has been used in testing river beds, in which there is always running water, is that of the spoon dredge, in which, as the name suggests, the spoon is the chief factor. It consists of a greenhide bucket, mounted on a steel frame, which acts as the lip; this is fitted on to a long pole, which, in turn, is pivotted in a convenient manner on a punt, on which a hand-winch is used, and a rope suitably led from the winch is attached to the spoon. The spoon is worked by the winch, and dragged alongside the punt.

The material that is raised in the bucket is emptied into a tub and cradled from time to time. While continually working the spoon and lowering it alongside the punt, the bottom or bedrock may be reached. This is then scraped up as far as possible. A fair idea may thus be obtained of the value of ground, although the method does not appear sufficiently accurate to estimate the contents per cu. yd., and would only be used in running rivers or lagoons.

Ground that will average 2 gr. of fine gold or 8 cts. per cu. yd. under good working conditions, will pay a dredge of 4½ cu. ft. bucket capacity.

## DREDGING OPERATIONS AND COSTS.

Having a complete plant erected and floating in its paddock, which is, to start with, an excavation deep enough for the dredge to float in and of sufficient dimensions to allow it to turn right round, the first object is to open out a face across the ground to be worked for its full width, and to get the buckets down on to bedrock as soon as possible. In carrying out this operation careful attention and skill is required in maœuvring the dredge, as there is little space for stacking the tailings.

The face has to be opened out in the shape of a fan and gradually worked ahead, lowering the buckets until the bottom is reached. In opening out deep ground one is often a month in getting on to bottom. If care is not taken in the initial starting of a plant the position may become so cramped that the dredge will finally become immovable and will have to be dug out. When once a wide paddock is opened out the dredge works with very little trouble. The face must be kept square and the corners of the paddock worked up, otherwise it will gradually narrow and ground will be left behind and lost. The tailings must also be evenly distributed at the stern.

To facilitate working, the mooring lines from the dredge, of which there are five (two lines on either side at the bow and stern and a head line), have to be properly set, so that the man working the winches has no trouble in moving from point to point.

Bow lines should always be set to run aft from the point where the line leaves the dredge, and the stern lines forward. A long head line is requisite as the dredge gets a better swing, and in working a wide face two pennants or free lines are moored in convenient positions to which the head line is attached with an iron shackle, as the occasion may require.

Deep trenches in the shape of a T are used for mooring the lines; a log with a chain sling secured round its center is thrown into the top trench and the sling is led out of the other and attached with a shackle to the dredge line. This mode of mooring is very strong and in general use.

In actual work there is very little that hinders operations and prevents the plant working up to full capacity in free running wash, unless large boulders are met with. Boulders that will come through the hanging bars of the ladder are raised to deck level and are then taken out of the bucket and thrown on to the deck; with a boulder that will not pass through the hanging bars a different method is adopted.

It may be pushed bodily along the bottom to the side of the paddock by the ladder and there left, or the buckets may be permitted to work away at the boulder until at length one lifts it. It then travels up the ladder until the hanging bars are reached, whereupon the friction clutch on the second motion shaft slips and the buckets will stop. They are then pulled out of gear, the machinery stops, and the ladder is raised until the stone appears above the water.

The dredge is then pulled round to bring the bows as near the tailings as possible, and by reversing the buckets the boulder is thrown back into the paddock out of the way.

Difficulties are at times met with in dredging logs and sunken timber, and much time is apt to be lost in their removal. The position in which a log may be found relatively to the face will determine the ease with which it will be extracted. A log laying parallel to the face of the paddock is easily stripped and removed, but when embedded at an angle it has to be got out in sections.

The buckets strip and lift the log about 10 ft. at a time. As soon as an end appears above the water a chain sling is thrown round it and attached to the rope from the derrick referred to previously, and a constant strain is kept on the log. As each portion is stripped and lifted above water-level, it is chopped off and swung round the side of the paddock with the derrick.

It is generally preferable to dredge with the buckets trailing on the bottom, so that the latter may be continually scraped and cleaned as the buckets revolve. The dredge works ahead, undermining the banks, and the upper wash or material will naturally fall to the buckets, when good work will result, and the dredge can then run for an hour or more with full buckets, without being moved. This will apply to a loose, free wash.

The case in which dredging with the buckets always on the bottom is not practiced, is when there is a layer of wash on the bottom only a few feet in thickness, over which there may be a depth of overburden carrying no values; under this circumstance, the wash is stripped and passed through the dredge separately. A cut of 3 to 6 ft. ahead is made over the wash, after which the dredge would be let back, the ladder lowered on to the bottom, and the wash raised and rock cleaned up.

Every means should be adopted to enable the dredge to work as many hours per day as possible, putting through as much ground as can be lifted; the matter of lost time, which is often overlooked in mining enterprise, appears to us to be of great moment in dredging operations. It may be that as the returns from a dredge are chronicled in ounces won, hours worked, and material treated, lost time is weekly brought under notice and is, therefore, more obvious than in other mining undertakings.

In working ground that averages not more than 4d. per cu. yd., which, with a dredge of 4½ cu. ft. capacity, would be profitable, provided sufficient material is treated weekly, it is evident that with a proposition of so low a grade there is not much margin for lost time and profit earning. All parts of the machinery should have effective automatic lubricators, or Staufer grease cups, so that little time is lost in oiling at each shift. Staufer cups have been found most efficient for lubricating on dredges wherever they can be used. The system is cheap, clean and lasting in the bearings without the latter heating. The mooring lines should be lifted while the plant is in motion as much as is possible.

CLEANING UP.—The sluice box or tables are cleaned up weekly, and the clean-up is conducted as follows:

In either case the ripples or expanded metals are lifted and the lighter material caught in the sluice box or tables is run off the mats by a gentle stream of water, the gold, heavy sands, and pieces of metal of any description, alone remaining. The mats being cleared, the water is turned off, and with the calicoes lifted and washed one by one into a gold-box or tub, and quite clean. When all the mats have been washed, they are relaid as before preparatory to starting work.

It may here be stated that if the sluice box or tables are properly built, with a pitch to suit the material treated, and with efficient ripples, it will be found that 12 ft. in the case of a sluice box and 6 ft. with tables, will have caught 90% of the gold saved. All the ripples, however, in a sluice box must be lifted weekly, otherwise the mats will become thick with dirt.

In the case of tables, laid with expanded metal, it is customary to only take up the top 6 ft. each week, the balance may be lifted once a month. These tables are most efficient gold savers, and we have found for a month's run that, by lifting the top mats weekly, 120 oz. of gold have been recovered therefrom, and when washing the bottom mats once only at the end of the month 30 dwt. was recovered.

The washings or sands from the mats and calicoes are run through a small sluice box about 15 ins. wide and 12 ft. long, called the streaming down box. This box is laid with either silk plush with a long nap, which is run against the water current, or ordinary green baize. The box is given a pitch of 1 in 12, more or less, according to circumstances, and the sand is fed in slowly by hand.

By careful "streaming down," as the process is called, the whole of the gold will be caught in the top 2 ft. of the box, and after all the sands have been treated the plushes or baizes are lifted and washed into a tub; the result is a concentrate which will fill about two-thirds of an ordinary prospecting pan. This is sieved, and any coarse gold panned off from the sievings, while the finer gold is collected by amalgamation.

The labor employed on a dredge is small. A full crew comprises 3 winchmen, each working a shift of 8 hours; 3 engine drivers, one on each shift, attend to the machinery and boxes, and fire the boiler. A laborer works on the day shift, supplying the dredge with fuel enough for the 24 hours, and attends to line shifting. The dredge master in command of the dredge superintends all operations. This, in most cases, is all the labor that is required. On sluice box dredges, when heavy wash is being worked, a boy on each shift is employed keeping the sluice run clear.

One of the engine drivers is an engineer [machinist] and fitter, a second a blacksmith, and the third a carpenter. A representative of each of these trades is necessary so that the crew may be able to attend to all repairs, etc., that may from time to time be essential.

In Australasia the rates of wages paid to the crews are usually as follows:

| | | |
|---|---|---|
| Winchmen | 10s. | per shift of 8 hrs. and overtime. |
| Eng. drivers | 8s. 4d. to 10s. | " " " " " |
| Boys | 4s. to 5s. | " " " " " |
| Laborers | 7s. 6d. | " " " " " |
| Engineers [machinists] | 4l. | " week and no overtime. |
| Dredge master | 6l. | " " bonus on returns. |

There is overtime worked each week, which the men do not object to, as the work, as a rule, is light, and consequently good wages are earned.

To make the data as to actual results and costs of dredging as reliable as possible, the figures for a year's work have been taken from the books of two dredges, both working under somewhat adverse conditions. The first is from a dredge working on the Buckland River, Victoria, and dealing with a quantity of sunken logs.

In the second case a severe winter hampered operations; the dredge worked in the Australian Alps on the Eucumbene River at an altitude of 5,000 ft., where, for several months of the year, deep snow lies on the ground and the thermometer falls at times to 20° below zero F. Lost time was occasioned by the dredge being frozen up. Following is a summary of results:

| | No. 1 Dredge. | No. 2 Dredge. |
|---|---|---|
| Full Working Time for a Year | 52 weeks or 7488 hr. in each case. | |
| Actual time worked | 6161 hr. | 5572 hr. |
| Percentage of lost time | 17.70 %. | 25.6 %. |
| Gross capacity of dredge | 130 cu. yds. per hr. | 112.5. cu. yds. per hr. |
| Material actually treated | 325,896.3 cu. yds. | 303,360 cu. yds. |
| *Percentage of material treated relatively to gross capacity for time worked | 40.6 %. | 48.0 %. |
| Gold recovered | 1198 oz. 12 dwt. | 1393 oz. 17 dwt. 22 gr. |
| Net value | £4815 19s. 2d. | £5103 18s. 1d. |
| Total working expenses | £3321 18s. 8d. | £4149 16s. 7d. |
| Net profit | £1494 0s. 6d. | £1954 1s. 6d. |
| Value per cu. yd. of material treated | 1.76 gr. or 3.5d. | 2.2 gr. or 4d. |
| Cost of treatment per cu. yd. | 2.4d. | 2.4d. |

*Calculated in each case with 4½ cu. ft. buckets, but in the first 13 buckets and in the second 11.25 buckets per minute were delivered.

THE PHOENIX (VICTORIA) GOLD DREDGING CO.,

Dredge Master's Weekly Report for Week ending August 11, 1905, including Summary of Labor employed, Supplies used, etc.

| | Hours run. |
|---|---|
| August 11— | |
| 12 p. m. to 8 a. m. Shift. Stopped 1 hr. cottering up bucket and removing boulders | 7 |
| 8 a. m. to 4 p. m. Shift. 3¾ hr. stoppage cleaning up boxes and repairing links | 4¼ |
| 4 p. m. to 12 p. m. Shift. Lost ½ hr. dredging boulders | 7½ |
| Hours worked | 18¾ |
| August 12— | |
| 12 p. m. to 8 a. m. Shift. No stoppage | 8 |
| 8 a. m. to 4 p. m. Shift. Lost ¾ hr. dredging boulders | 7¼ |
| 4 p. m. to 12 p. m. Shift. Broke piston rod on winch engine; lost 3 hr. repairing | 5 |
| Hours worked | 20¼ |
| August 14— | |
| 12 p. m. to 8 a. m. Getting up steam, dredging boulders; lost 2 hr. | 6 |
| 8 a. m. to 4 p. m. No stoppage | 8 |
| 4 p. m. to 12 p. m. Lost ½ hr. dredging logs | 7½ |
| Hours worked | 21½ |
| August 15— | |
| 12 p. m. to 8 a. m. Lost ½ hr. dredging boulders | 7½ |
| 8 a. m. to 4 p. m. No stoppage | 8 |
| 4 p. m. to 12 p. m. Put new valves in air pump. Stopped 1 hr. | 7 |
| Hours worked | 22½ |
| August 16— | |
| 12 p. m. to 8 a. m. Lost 2 hours lifting numerous boulders causing great trouble | 6 |
| 8 a. m. to 4 p. m. Stopped whole Shift repairing bottom tumbler | 0 |
| 4 p. m. to 12 p. m. No stoppage | 8 |
| Hours worked | 14 |
| August 17— | |
| 12 p. m. to 8 a. m. Struck big log on this Shift. Lost ½ hr. | 7½ |
| 8 a. m. to 4 p. m. Extracting portion of log. Lost 1 hr. | 7 |
| 4 p. m. to 12 p. m. Log in the face; removing another section. Lost 1½ hr. | 6½ |
| Hours worked | 21 |

RESULTS.

| | |
|---|---|
| Gold won | 52 oz. 6 cwt. 12 gr. |
| Hours worked | 118½ |
| Material treated | 5,862 cu. yd. |

Remarks.—We had a short run this week, repairing bottom tumbler, etc., and the usual delays. The ground, however, has deepened and the return has increased 10 oz. on the last. Width of face, 6 chains, depth of ground varying from 9 to 30 ft.

| Name of Workman and Occupation— | Hours Worked. | Rate per Day. s. d. | Amount. £ s. d. |
|---|---|---|---|
| H. Farr, winchman | 54 | 10 0 | 3 7 6 |
| A. Boness, winchman | 48 | 10 0 | 3 0 0 |
| J. Hughes, winchman | 50 | 10 0 | 3 2 6 |
| A. Beckwith, engineer | 64 | 11 0 | 4 8 0 |
| R. Yule, fireman | 58 | 8 4 | 3 0 5 |
| J. Beckton, fireman | 48 | 8 4 | 2 10 0 |
| J. Bell, blacksmith | 51 | 8 4 | 2 13 1 |
| E. Render, boy | 62 | 4 2 | 1 12 3 |
| E. McCormack, boy | 50 | 4 2 | 1 6 0 |
| A. Jessop, boy | 16 | 4 2 | 0 8 4 |
| C. Bell, boy | 32 | 4 2 | 0 16 8 |
| H. Turner, laborer | 40 | 8 0 | 2 0 0 |
| J. Robertson, dredge master | .. | ... | 6 0 0 |
| | | | £34 4 9 |

SUPPLIES.

| Description and Quantity. | Cost. £ s. d. |
|---|---|
| Firewood, 19 cords | 11 17 6 |
| Engine oil, 23 gals | 0 14 4 |
| Cylinder oil, 4 gals | 0 3 4 |
| Cotton waste, 7 lbs | 0 2 4 |
| Charcoal, 4 bags | 0 6 0 |
| Manhole jointing | 0 4 0 |
| Richards metal, 15 lbs | 1 13 9 |
| | £15 1 3 |

REPAIRS.

| | £ s. d. |
|---|---|
| Repairing links and buckets, workmen's time | 3 2 4 |
| Bucket rivets, 33 lbs | 0 4 1 |
| Bucket lip | 1 2 3 |
| Cleaning out boiler (wages) | 1 6 7 |
| Repairs to bottom tumbler, wages, and brushes | 8 0 0 |
| | £13 15 3 |

TOTAL EXPENDITURE.

| | £ s. d. |
|---|---|
| Labor | 34 4 9 |
| Supplies | 15 1 3 |
| Repairs | 13 15 3 |
| Total | £62 11 3 |

The working expenses for weekly expenditure run as follows:

No. I Dredge.....£63 17s. 7.2d.
No. II Dredge.....£60 11s. 5.7d.

The weekly expenditure in each case was made up of the following items:

| | No. 1. Dredge. £ s. d. | No. 2 Dredge. £ s. d. |
|---|---|---|
| Wages | 30 17 1.2 | 30 15 11.2 |
| Repairs and renewals | 10 15 4.4 | 6 10 1.7 |
| Fuel | 8 17 7.4 | 5 15 11.9 |
| General expenses | 0 15 2.5 | 1 5 10.5 |
| Traveling expenses | 0 3 3.8 | 0 2 3.5 |
| Rent on leases | 0 10 8.9 | 3 19 9.7 |
| Freight and cartage | 1 0 7.2 | 1 1 2.0 |
| Insurance | 0 11 7.5 | 0 15 2.3 |
| Dredge supplies | 0 16 1.8 | 0 14 4.2 |
| Office and management | 9 9 10 5 | 9 10 8.7 |
| | £63 17 7 2 | £60 11 5.7 |

On comparing the above figures, it will be noted that the extra cost of fuel, repairs and renewals, in the first case, and high rental in the second, are the chief items of difference in the cost of running each dredge.

In checking a week's work for a dredge, so that the results may be seen at a glance, the accompanying form, filled in from a Dredge Log Book, may be interesting, as showing the method used by the author for checking causes occasioning lost time, and the cost of labor, supplies, repairs, etc.

The foregoing figures show the possibility of profits that may be earned by a bucket dredge working under favorable conditions.

There are undoubtedly still extensive fields in various parts of the world open to the dredging industry, and this applies, in our opinion, to dredging for stream tin as well as for gold.

In working a bucket dredge for tin, it is claimed by many that the surging of the dredge, and, consequently, the alteration in the pitch of the tin-saving tables, causes great loss, and that the method of work in this case should be by hydraulicing and elevating with centrifugal pumps, commonly called pump dredging. This method of work cannot now be entered into as, with the improvements that have been made in the last five or six years, the subject deserves a special paper, which must be reserved for some future date.

With regard to the relative merits of the two processes for the recovery of tin, we have shown that a bucket dredge can work at a profit on ground of a gross value of less than 8 cts. per cu. yd. On the other hand, even working on the largest scale so far attempted, the working expenses alone of the pump amount, so we have been credibly informed, to 9 cts. per cu. yd. It should be obvious, therefore, that, allowing an inferior recovering capacity for the bucket dredge, this would be counterbalanced by the smaller working expenses.

We have striven in the foregoing notes to give a general outline of dredge work, and as the details are records of actual work, we trust they may be of some use to those interested in the subject.

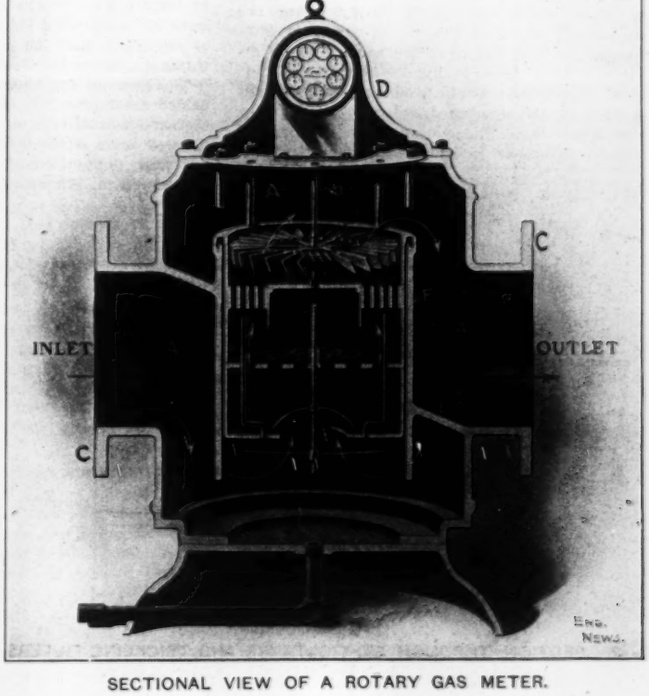
## A GAS METER OF THE ROTARY TYPE.

The rotary gas meter is a comparatively new invention for the measurement of all kinds of gases or air. It consists of a cast-iron body (A) (see accompanying figure) and base (B) with flanged nozzles (C) for connection to gas pipes. The body is surmounted by a cast-iron hood (D) which contains the recording mechanism. The inlet and outlet are separated by an oblique partition (E) and a vertical tube (F) which contains the working parts of the meter. These consist essentially of a turbine wheel (a), with vanes set at an angle of about 45°, mounted on a vertical shaft (b) running in jeweled bearings. A worm gear on the shaft engages and operates the recording mechanism. Located directly below the turbine wheel is a series of vertical holes in plate (c) which serve to direct the gas against the blades of the wheel at the proper angle to produce rotation. A light valve (d) prevents the gas from flowing backward through the meter, although its principal object is to cause a small quantity of gas at slightly increased pressure to pass directly through the tubes (e) to the vanes of the turbine, thereby insuring its rotation at small rates of flow. These working parts are contained in a case (G), which is easily removed from the body (A) after hood D has been taken off.

The advantages claimed for this type of meter over other types are ease and quickness of repairs, the working parts being readily removed and new ones substituted, since all parts are interchangeable; compactness, the meter being much smaller than other types, requiring amout 1/10 the space, capacity for capacity; accuracy of readings, the meters being fitted with a patented mechanism which automatically registers the correct amount of gas, no matter whether the pressure is low or high, providing the temperature remains constant.

These meters are not adopted for use in measuring very small quantities of gas, but for station use they have proven very satisfactory. The minimum measuring capacity of any rotary meter is 1/10 its maximum capacity. Another style of meter has been developed for use where a small quantity of gas is used, that is for registering the amount used in gas stoves, grates, etc., the meter being located near to the apparatus and within view of the user. These meters are very small and compact and embody the same general principle of design as the larger station meters. All rotary meters are direct reading, being so constructed that they are self-correcting for all variations in rate of flow of gas through them.

These meters are manufactured by the Rotary Meter Co., 280 Broadway, New York City.




SECTIONAL VIEW OF A ROTARY GAS METER.

EXPERIMENTS WITH A SUBMARINE TELEPHONE line are now being carried on at Lake Constance. The cable is about seven miles long and reaches a maximum depth of 820 ft. below the surface. It connects Friedrichshafen, Germany, with Wurtemberg and Romanshorn, Switzerland, and was constructed according to Prof. Pupin's system (Eng. News, Vol. XLIV., p. 133) for long distance telephoning, in which he incorporates inductances into the cable to compensate its capacity.

THE SUEZ CANAL is being deepened to give 31 ft. of water so as to allow of taking vessels of greater draft; at present the depth prevents any material increase in the size of steamers of the various lines between British and oriental ports, while some large battleships have to transfer their guns to lighters and go through with coal bunkers almost empty. In 1902, the permissible draft was increased from 25 ft. 7 ins. to 26 ft. 3 ins. In connection with the deepening, the curves are being improved and widened and at certain points the bottom width is being increased from 102 ft. to 128 ft., while in the Bitter Lakes the channel is being widened to allow ships to pass. The average width at the water surface is from 300 to 360 ft. in the northern part and from 240 to 300 ft. in the southern part. It is suggested that the entire canal should be widened to a bottom width of 150 ft., so as to enable ships to travel continuously in opposite directions instead of having to wait at passing places. One reason for this is said to be the promotion of a scheme for a rival canal.

## THE TRICKLING FILTER AT THE SEWAGE EXPERIMENT STATION OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

By C.-E. A. Winslow* and Earle B. Phelps.†

The Sanitary Research Laboratory and Sewage Experiment Station of the Massachusetts Institute of Technology was founded in 1902 by an anonymous donor for the purpose of making experiments upon improved methods of sewage disposal, especially those adapted to large cities. The donor has supported the work of the station by gifts of $5,000 a year, to be used for the following purposes:

(1) For keeping up with the investigations of the best men in all countries. (2) For utilizing this knowledge in the work of the Institute. (3) For original experiment. (4) For distributing all over our country in such words that they who run may read the results of the work. (5) For inciting the student to make plain and simple statements of the results of their studies.

An experiment station and laboratory were fitted up at 786 Albany St., Boston, and the work of the station was organized under the direction of Prof. W. T. Sedgwick, with Prof. C.-E. A. Winslow as Biologist-in-charge and Mr. Earle B. Phelps as Research Chemist and Bacteriologist. A series of papers upon preliminary questions in sewage chemistry and bacteriology was published in the supplement of May, 1905, to the Journal of Infectious Diseases, as Volume I. of contributions from the laboratory; and a second collection of miscellaneous papers on subjects relating to sewage disposal is now in course of preparation as Volume II.

The main work of the first two years of the station, 1903-5, consisted in a series of tests, on a practical scale, of various methods which could be used for the treatment of Boston sewage. Septic tanks, contact beds, sand filters and trickling filters were studied, each unit being a cypress tank of 72 to 96 cu ft. capacity. The results were presented in preliminary form in the 1905 volume of the Proceedings of the American Public Health Association and are now being prepared for final publication as Volume III. of Contributions from the Laboratory. They showed in a general way that the sewage of the South Metropolitan District of Boston is a fairly typical American sewage, somewhat stronger than the average; that as a preliminary treatment the removal of .65 cu. yds. of solids per 1,000,000 gals. of sewage by grit chamber treatment would be desirable, the resulting sludge being mainly inorganic and inoffensive; that septic tanks would remove about two-thirds of the suspended organic matter and would liquefy it most successfully when operated at a short period, say eight hours; that sand filters could thoroughly purify either the crude sewage or septic effluent at a rate of 400,000 gals. per acre per day, the sewage being divided into four doses in the 24 hours; and that double contact beds would produce a fair effluent at a rate on the combined area of 700,000 gals. per acre per day. The contact beds so operated decreased in capacity and would doubtless require renewal after several years, and there can be no doubt that the sand beds would also require renewal. Experience in Massachusetts with town disposal areas has shown quite clearly in recent years that sand beds are not permanent even at rates of 50,000 gals. per acre per day.

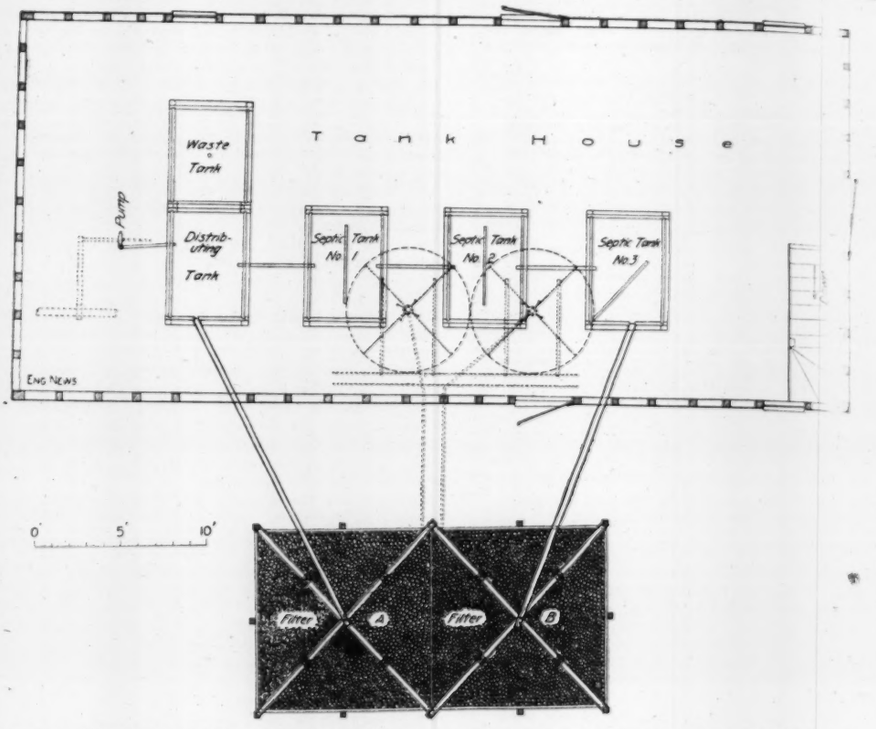



FIG. 1. GENERAL PLAN OF SEPTIC TANKS AND TRICKLING FILTERS AT THE SEWAGE STATION OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Experiments with continuous trickling or sprinkling filters showed results equal to those obtained with the double contact system at much higher rates, and suggested that this method would probably prove the most practical one for use. We felt disinclined, however, to base any conclusions on the study of filters of this type of so small a size as 96 cu. ft., operated under cover, and therefore constructed a larger outdoor bed upon which studies have been carried out since September, 1905. We plan to continue them for at least a year more, but the first eight months have shown such good results that a description of the filter may be of interest at the present time.

The sewage for the use of the station is obtained from the 9-ft. trunk sewer of the South Metropolitan district at a point where there is a flow of some 30,000,000 gals. a day from a contributing population of 250,000. It is drawn up by a 4 × 6-in. Warren duplex pump, being roughly settled on the way by passage through a grit chamber 19 ins. in diameter and 16 ins. deep, fitted with a screen whose bars are ½ in. apart. The sewage is then raised, without further sedimentation, by a ¾-in. centrifugal pump, to the distributing tank, shown in the plan and section, Figs. 1 and 2. No sludge is removed from this tank, the contents of which are stirred up several times a day in order to prevent any accumulation. The pumpage into the tank is kept always in excess of the outflow, and a constant head is maintained, by wasting over a 36-in. weir at one end. From the opposite end of the distributing tank sewage flows to one-half of the trickling bed, Filter A, over a ½-in. brass weir, the crest of which is raised or lowered by a micrometer screw. By regulation of this crest in relation to the constant height on the waste weir it is possible to obtain any desired flow on the filters. A depth of about 1 in. on the small weir corresponds to 200 gals. per hour, or 2,000,000 gals. per acre per day, the rate at present in use.

From one side of the distributing tank sewage flows continuously through a short length of 2½-in. iron pipe to the first of the septic tanks. These are open cypress tanks 6 × 4 ft. × 3 ft. deep, connected in series by 2½-in. iron pipe. The whole series, including the distributing tank and the three septic tanks, are thus in open connection, the level in all being controlled by the large waste weirs of the distributing tank. Each septic tank is provided with a single central wooden baffle, arranged as shown in Fig. 2. The total capacity of the septic tanks is equal to seven hours' flow and the division into three tanks makes it possible to study successive stages in the septic process. From the last tank, a 1-in. brass weir, exactly like that on the distributing tank, regulates the flow on the second section of the trickling bed, Filter B.

A general view of the trickling bed is shown by Fig. 3. Its superficial area is 200 sq. ft., and its depth 8 ft. It is divided from top to bottom by a central partition of 2-in. spruce planking, with matched joints, making two separate beds, each 10 ft. square. Filter A takes crude sewage and Filter B treats septic effluent. Both beds are filled with crushed stone, granite and trap, between 1 and 2 ins. in diameter.

The construction of the filters was as follows: For a foundation, 4 × 4-in. spruce beams were buried in the ground, with top surfaces flush. A hemlock floor 1 in. thick was next laid and covered with a layer of 1 to 2 Portland cement mortar, 1 in. thick at the inner corner of the filters near the tank house and sloping up to a thickness of 3 ins. at the opposite side. Four radiating channels in the cement, ½ in. deep, aid the flow to the inner corners, from which the effluent is conducted into the tank house by 1½-in. iron pipes, 8 ft. long, with a slope of about 1 ft. The sides of the filter (Fig. 3) are of spruce planks, with ½ to 2-in. openings between them.

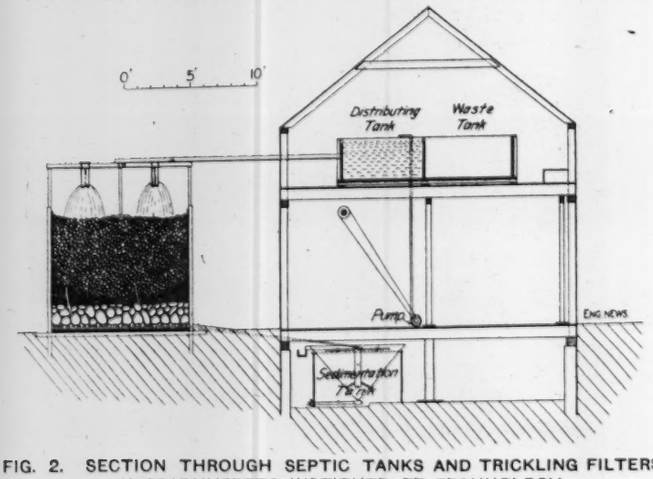



FIG. 2. SECTION THROUGH SEPTIC TANKS AND TRICKLING FILTERS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

*Massachusetts Institute of Technology, Boston, Mass.
†786 Albany St., Boston, Mass.

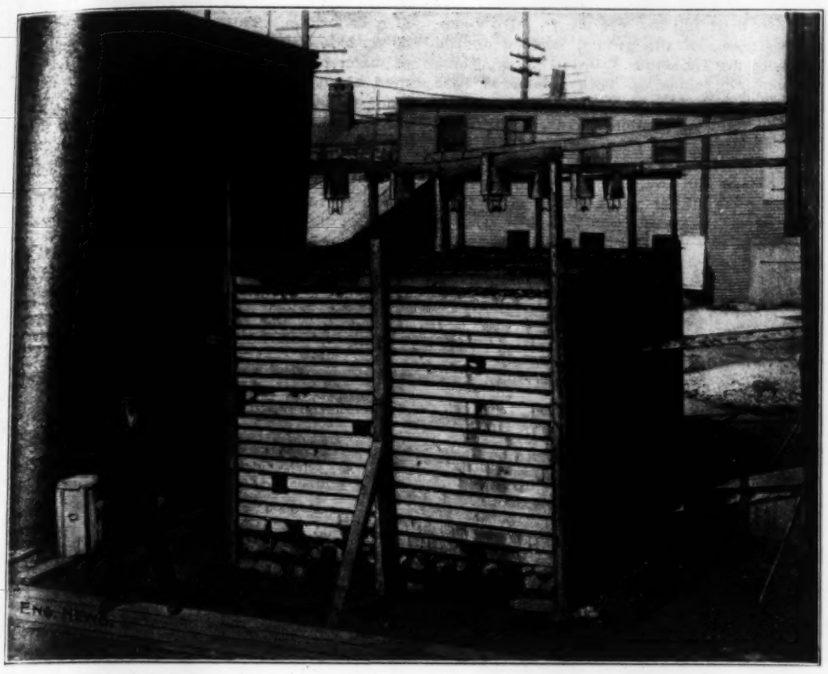


FIG. 3. GENERAL VIEW OF TRICKLING FILTER, MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

the lower 18 ins. being entirely open. These sides are supported by 4 × 4-in. uprights braced on all sides and tied at the tops by ½-in. iron rods. On the cement floor, two layers of brick are laid in open courses, as shown in Fig. 4, to ensure good underdrainage. On these are 18 ins. of boulders, graded from 12 ins. up to 4 ins., and above the boulders are 65 ins. of the main filling material, 1 to 2-in. crushed stone.

The method of distribution adopted is somewhat different from any hitherto suggested. We desired a system which should be as simple as possible in operation, and felt that pressure could be saved and small orifices avoided by reversing the usual process of spraying upward. We have therefore devised a system of gravity distribution by splashing from metal disks, which is here described for the first time. The sewage from the two dosing weirs, in the distributing tank and in septic tank No. 3, flows out from the tank house through open wooden troughs 3 ins. in width and 3 ins. deep. From these the sewage drops into similar troughs which run from corner to corner of each of the two filters, joining at the center in the form of a cross. The sewage passes into this cross at its center, flows out into the four arms and drops through ¾-in. holes to the disk distributors, four to each bed 100 sq. ft. in area. In each hole is a 3-in. piece of ¾-in. brass tubing, threaded on its upper inch and screwed to a lock nut inside the trough. Any inequality in distribution, due to change in the level of the distributing troughs, may be easily corrected by changing the position of this short tube. Below the troughs the stream of sewage is protected from the wind by a box extending down for 12 ins. and at 15 ins. below the trough it strikes a shallow concave disk from which it splashes outward. On the filter, as operated at present, these disks are 3 ins. in diameter, and their concavity has a 6-in. radius. They are made of four different alloys, the durability of which we desire to compare. Each is held in place by four ¼-in. brass rods. The general arrangement of the distribution system is shown in Fig. 3. It has worked with fair success, spreading the sewage well and not requiring an excessive amount of attention. No difficulty was experienced during the winter of 1905-6. On the coldest days an umbrella of ice surrounded each disk, as shown in Fig. 5, somewhat limiting the surface distribution, but within this shield the spray worked well. The holes in the bottoms of the troughs clog occasionally and one or two of the eight require attention perhaps once a day. On the whole, we are inclined to think that the slight head required and the fact that the smallest opening liable to clogging is ¾-in. in diameter are distinct advantages for this system of gravity distribution. The head of 26 ins. between the disks and the surface of the bed might be materially reduced if desired.

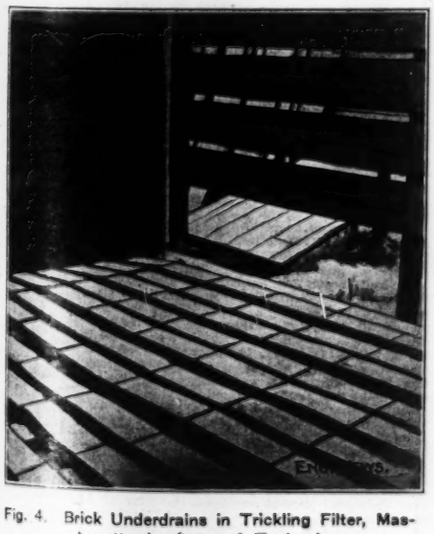


Fig. 4. Brick Underdrains in Trickling Filter, Massachusetts Institute of Technology.

We do not consider our distributing device wholly satisfactory as yet, and are at present carrying out experiments on the comparative evenness of distribution obtained with different types of pressure nozzles and gravity disks under varying conditions of flow and head. The general plan of gravity distribution, however, seems promising.

The effluent from each filter, as pointed out above, is conducted by the sloping cement floor to the inner corner of each bed, thence flowing through 1½-in. iron pipes to the lower floor of the tank house. Here the effluents from the filters are sedimented in tanks of special design, of No. 18 galvanized iron, treated with several coats of asphaltum paint. Each is a simple cone, with a diameter at the top of 7 ft. 2 ins. and a height of 4 ft. This form is not so favorable for sedimentation as the Dortmund tank, with sides parallel in the upper part, but was adopted to suit the head room and area at our disposal. At the center of each tank is a vertical tube 6 ins. in diameter extending to within 1 ft. 3½ ins. of the bottom. Into the top of this tube the filter effluent is discharged, its flow being broken by a 3-in. conical cup. The liquid passes out into the tank near the bottom of the tube through openings in its sides. Sludge is removed once a day or once in two days from the bottom of the tank by the valve shown in the diagram. The supernatant liquor rises and overflows through two 2 × 3-in. collecting troughs. The total capacity of each tank is 415 gals., which gives a two hours' storage period when the filter is running at a rate of 2,000,000 gals. per acre per day.

The filters have so far acted with success, yielding, as most filters of this type do, effluents which are somewhat turbid in appearance and high in total organic matter, but stable and well oxidized. The preliminary septic treatment appears to be a distinct advantage. It is planned, as has been said above, to continue the experiments for at least a year more, testing the effect of variations in distributing devices, depth, rate, etc., before the publication of detailed results.

GAS POWER FROM BLAST-FURNACE AND COKE-oven gas in Germany was discussed by Mr. H. Hoffmann, of Bochum, Germany, at the recent annual meeting of the Verein Deutscher Ingenieure. The following figures given in his paper are of interest: During the current year Germany will produce about 20,000,000 tons coke and 12,000,000 tons pig iron. The gas of the blast furnaces is capable of producing about 1,000,000 HP. if utilized in gas engines; utilized for raising steam to be used in the best class of steam engines or steam turbines about half as much power could be obtained. The waste heat and gases from the coke ovens could produce about 500,000 HP., under present conditions, or about 600,000 HP. if all coke were produced in regenerative byproduct ovens, whose waste gases would be used in gas engines. The total power possibility thus is about 1,600,000 HP. Roughly one-fourth of this power is now being developed (or to be developed, the list including gas engines in operation and under construction): 125 blast-furnace gas blowing engines aggregating 156,000 HP.; 175 blast-furnace gas generator sets aggregating 193,000 HP.; 11 blast-furnace gas rolling-mill engines, 17,000 HP., and 47 coke-oven gas generator sets, 40,000 HP.; a total of 358 gas engines of 406,000 HP. capacity. The average capacity per unit is thus about 1,100 HP. It will be seen that over half the total gas-engine capacity is used for generating electric current. Electric pumping and shaft hoisting are important elements in this consumption of current, besides, of course, the much more general use for lighting, crane work, transportation, etc. A number of electric rolling-mill drives are also in operation; two electric companies have in operation or on order no less than 170 electric rolling-mill drives, totaling 100,000 HP. capacity; of these 5 are for reversing mills.

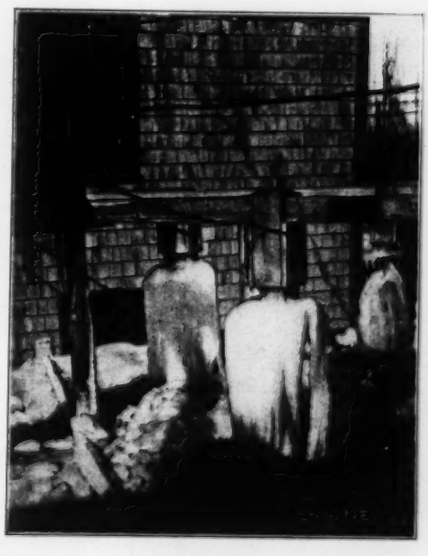


Fig. 5. Ice on Distributors and Surface of Trickling Filters, Massachusetts Institute of Technology.

## A DETERMINATION OF ACTUAL EARTH PRESSURE FROM A COFFERDAM FAILURE.

By Thos. C. J. Baily, Jr., M. Am. Soc. C. E.*

There are so few actual known values for earth pressure, the writer has thought the following case in which the resulting pressure for a certain height could be obtained within a comparatively small limit of error might be of interest. The case referred to was the failure of a portion of a cofferdam on work under the writer's charge, and in accordance with his usual practice to have any unusual occurrence carefully analyzed he had one of his assistants, Mr. F. C. Wight, work up the matter carefully. It may be noted here that this slight accident probably saved the contractor from the loss of the entire cofferdam, as immediately afterwards he entirely remodeled his system of bracing.

The accident in question occurred at an excavation made between triple-lap dressed 2-in. sheet piling. The wall affected by the failure is shown in Fig. 1, which needs but little explanation. The site had been filled at least 40 years previously; the top 6 ft. was unusually good material of well-compacted dirt and gravel, under which was a wet clay and gravel, a very troublesome material. The lower walling piece was an 8 × 12-in. timber of old yellow pine and had been used before on another job. This piece failed, at a time when no rains of any moment had occurred for a considerable period preceding, in the manner indicated in Fig. 1. A heavy deflection of the piece occurred before the break, showing that the bending moment acting on the piece was but slightly greater than its resisting moment.

The wale acted as a simple beam spanning 17 ft. 4 ins., between centers of transverse braces. Its modulus of rupture was probably not over 5,000 lbs., and on this basis its resisting moment at the section of fracture (which was located at a point where the piece had been cut down to 8 × 8½-in. section) was 455,000 lb.-ins.

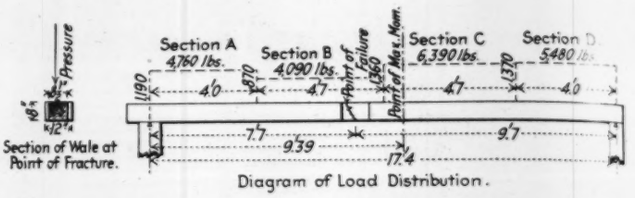
As to the load on the wale, it is to be observed that the tongue-and-grooving in the sheet piles was not at all tight, and allowed little or no horizontal beam-action in the sheathing. Each sheet pile, therefore, acted merely as a transmitter of the earth thrust to the upper and lower wales.

The earth-pressure was computed on the basis of the actual weight and angle of repose of the material. A mean of three measurements of the angle of repose of the loose material from the excavation, which had been piled by a derrick about 15 days before, was 39° with the horizontal. The gravel and dirt (upper layer) weighed about 108 lbs. per cu. ft. packed, and the clay and gravel (lower layer) about 132 lbs.; the mean weight of a mixture of the two materials was about 120 lbs. per cu. ft. Cross-sections were taken of the ground surface on the side opposite the wale that failed (the conditions being about the same on both sides), at four points, with results shown in Fig. 1. The earth pressure for these sections was obtained by graphical application of Coulomb's method, with 100 lbs. per cu. ft. for unit weight and 35° for angle of repose (the writer's usual assumptions for designing retaining walls. This gave horizontal loads on the beam as sketched at A in Fig. 2. The bending moment at the point of fracture under these conditions would be 506,640 lb.-ins., which is 11% greater than the probable resisting moment as estimated above. Another calculation of the earth-pressures, on the assumption of 120 lbs. per cu. ft. for unit weight and 39° as angle of repose, gave a bending moment of 466,200 lb.-ins., which is only 3% greater than the probable resisting moment.

As the failure occurred very slowly, and when no excavation was being carried on in this part of the trench, the moment of external forces was but slightly in excess of the resisting moment. The computation of the earth pressure, therefore, involves only such errors as are contained in the estimate of the resisting moment of the wale. Now, the possible error in the latter is wholly in the assumption as to modulus of rupture. Even if this be in error by 1,000 lbs. in either direction, certainly a maximum allowance, the error in the earth pressure calculation would be not over 2%.

The difference in the constants of the upper and lower materials would affect the computations slightly, and if the modulus of rupture of the wale were known more definitely, it might be worth while to take this difference into account. The angle of repose of the upper 6 ft. was probably about 45°, that of the lower 5½ ft. about 33°. The probable load distribution must therefore have been similar to that indicated by the shaded area in sketch "B," Fig. 2. In this case the center of pressure would be somewhat lower than above calculated on the basis of homogeneous material, and the proportion of load going to the lower wale would be somewhat greater.

TWO OTHER CASES.—Some time ago the writer had occasion to investigate the distortion of a cofferdam. This dam was dredged to about 30 ft. below the water surface inside, with 6 ft. of water outside, supporting a bank of soft river mud about 24 ft. high. Although the structure was statically indeterminate, computations indicated that these distortions could be caused by the pressure of a liquid weighing 25 lbs. more than water, or of a liquid weighing from 87 to 90 lbs. per cu. ft. Of course the mud was submerged.



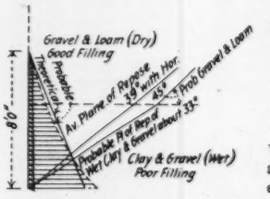




FIG. 2. DIAGRAM OF DISTRIBUTION OF EARTH PRESSURE TRANSMITTED TO LOWER WALL OF COFFERDAM.

In another case investigated by the writer, that of a wall about 50 ft. high above the ground, which showed a tendency to fail, a reasonable interpretation of theory gave a maximum pressure at the toe of about 11 tons per sq. ft., while an actual test load at this footing showed that the ultimate value of the material was about 10 tons.

The writer would like to hear further of cases in which the actual earth pressure has been obtained within reasonable limits.

*531 Randolph St., N. W., Washington, D. C.

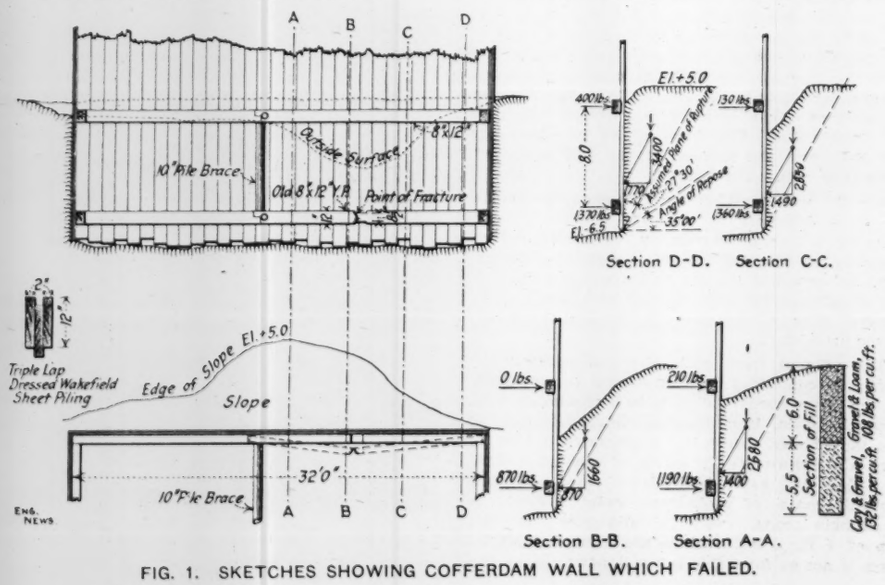



FIG. 1. SKETCHES SHOWING COFFERDAM WALL WHICH FAILED.

ARGUMENTS AGAINST MUNICIPAL TRADING, as what we term municipal ownership is known is England, were presented recently at the fourth annual meeting of the Industrial Freedom League by Lord Avebury (better known in this country as Sir John Lubbock). These arguments, as reported in the London "Surveyor," reflect the opinions of many of the relatively small band of opposers of municipal ownership in England. We quote the account of the remarks as given in the "Surveyor," as follows:

Lord Avebury said he regretted the present tendency to municipal trading on five grounds—in the first place, the legitimate duties of our municipalities were already enough, if not indeed more than enough, to tax all their energies; secondly, it would involve an immense increase in municipal debt; thirdly, it would involve municipalities in labor disputes; fourthly, as there would not be the same stimulus to economy and attention, there would be a great probability, not to say certainty, that one of two things would happen—either there would be a loss, or the service would cost more; and, fifthly, it was a serious check to progress and discovery. As to the first point, if a man gave his whole time and thought to the London County Council he could not get through the work. Hence it was becoming more and more difficult to find good men willing to serve, and the work was falling more and more into the hands of officials. He was not attacking those gentlemen, but the system. The number and variety of enterprises contemplated was increasing. The advocates of the policy would extend it to all kinds of business. As to the second point, municipal indebtedness rose from £103,000,000 in 1883-4 to £469,000,000 in 1903-4. Many viewed with great apprehension the continual increase in the number of state and municipal employees. Autocracy was another name for bureaucracy. His fourth objection was often contested. It was alleged that profits were made. Of course, when municipalities had monopolies and could charge what they liked that was in one sense the case. They took what they chose out of the pocket of the ratepayers and called it a profit. He doubted whether they ever made a profit where they had not a monopoly. They who were engaged in commerce knew that profits depended on close attention to details, on watching the turn of the market, on giving mind and thought to the business. It was impossible for the members of municipalities to do that, and consequently municipal management could not be as economical or as successful as private management. But it was said that as a matter of fact profits were made. In many cases, at any rate, the profits were imaginary. Too little was allowed for depreciation, for rent, for legal and clerical expenses. In many cases in electric lighting an undue amount was charged to street lighting, in tramways too much was charged to street improvements, in housing schemes the cost of the land was sometimes taken below the cost price, and so on. Taking the accounts as given, the number of electric light undertakings which had been working for twelve months was 191. The capital expenditure had been £27,000,000, on which the profit claimed had been £341,000. The amount put to depreciation, however, was only 1%, which was absurd; if 2½% had been allowed, which was quite a minimum, this would amount to £673,000, and would have turned the so-called profit into a heavy loss. Forty-eight municipalities worked tramways. Of these only 13 made any contribution to the rates. 17 made no depreciation allowance, and only 11 over 2%. As regarded the fifth point, all economists from the time of Adam Smith to Fawcett had strongly urged that interference by states or municipalities with trade was economically a fatal mistake.

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The expected has again happened, this time in the advice of Messrs. Hazen & Whipple that Paterson, N. J., join in the Passaic Valley trunk sewer scheme, instead of "going it alone" and building sewage purification works. True, the engineers qualify their recommendation, as outlined elsewhere in this issue, but in the main they support the conclusions of the various engineers and commissions that have preceded them, including among the former the late A. Fteley and also Mr. Rudolph Hering.

The septic tank, with plain sedimentation as a possible alternative, and the percolating (or sprinkling) filter are now making rapid headway in America, as they have been for a few years past in England. We have already recorded their adoption at Columbus, O., after extensive tests carried out by the city. Elsewhere in this issue we record their virtual adoption by Baltimore, Md., after careful expert study, and also their recommendation for Paterson, N. J., in case the cheaper trunk sewer project, mentioned just above, is not carried out. A remarkable feature of the Baltimore and Paterson plans is the proposal to use percolating filters 9 ft. in depth at the former and 10 ft. in depth at the latter place. Such depths were early indicated as possibly desirable by British studies, but have rarely been adopted, so far as we remember, and where adopted not on a large scale. This is not saying, of course, that great depth in percolating filters may not be desirable.

That the nomenclature of sewage treatment is by no means fixed is evident from the fact that the Baltimore and Paterson reports, mentioned above, use the term "sprinkling filters," while at the sewage experiment station of the Massachusetts Institute of Technology (see article in the front part of this issue) the choice has fallen on "trickling filters." This journal, its readers may have noted, adopted the term "percolating filters," some two years ago, and has since used that term, even though "sprinkling filters" now seems to be coming into general use here. The words "percolating" and "trickling" picture the way in which sewage passes through the beds, just as "contact" describes the relation of the sewage to the filtering material in contact beds. "Sprinkling," on the other hand, describes the method of application only. The classic term "intermittent filtration" involves still another phase of treatment, the time-element of application of sewage, rather than the way the sewage is applied, as in the case of "sprinkling filter," or the relation of the sewage to the filtering material, as in "percolating" or "trickling" filters and "contact beds." The discussion might be carried further, but our only wish at present is to call attention to the desirability, in the early stages of the newer processes of treatment, of a fairly, uniform, descriptive sewage works terminology.

The vast majority of the people of the United States are neither stockholders in any of the so-called trusts nor members of any of the labor organizations. It is not surprising, therefore, in view of the general agitation against both trusts and unions, to hear of various attempts to organize the "common people" for protection against both trusts and unions. An organization called the Citizens' Industrial Association of America (St. James Building, New York City) urges that "political candidates throughout the country" be asked these "two questions":

> Have you pledged your support to the Labor trust or to any other trust, organization, or corporation seeking special legislation?
>
> Will you or will you not represent the citizens as a whole and seek to protect them from class legislation, whether by organized capital or organized labor when such legislation is in the interests of the few to give power over the many?

We print the foregoing questions as of possible interest to some of our readers, and not to raise a discussion.

The marked advances in the price of lumber and various other materials is bound to have far-reaching effects on the choice of materials used and methods employed in engineering work. An interesting example of this, which is of moment to many of our readers and also to the municipalities of the country, is afforded in the course of a paper printed elsewhere in this issue, entitled "Recent Developments in Wood Block Paving." This paving material has passed through some very interesting stages of development in the United States. In the early days, more particularly in certain cities of the Central West, round cedar blocks were extensively used, but for the most part they fell into disfavor and in some cities they were soon abandoned. Their use in a few localities, however, was, and we believe still is, considered advantageous in view of the abundance and low cost of the material. This cost was so low that it was considered worth while to put down the round blocks in their natural state, even though it was necessary to replace them in a few years. Some of the worst defects of these and other wood block pavements in the days of their disrepute were due to lack of proper foundations. Outside of the regions where wood paving blocks could be obtained at a very low price, this material was very little used in this country until within the past few years. Abroad, however, hundreds of miles of excellent wood block pavements have been in use for a long time. These blocks are rectangular, and, when the Australian hard woods are not employed, they are frequently but not always treated with a preservative. They are invariably, we believe, laid on a good foundation. A few years ago, rectangular wood blocks treated with a preservative were introduced in this country, first by a company operating in the Central West and later by another company operating at the start in the Northeast. The bulk of the improved wood pavements thus laid for a number of years consisted of long-leaf yellow pine. The Eastern company treated these blocks with creosote and resin. The growing scarcity and price of suitable yellow pine and the great advance in the cost of resin have led this company to make the changes in its materials noted elsewhere in the paper by Mr. Kummer. For details of these changes, interested readers are referred to the article in question; but it may be noted here that a Southern gum wood is being used in place of yellow pine, and with promising results. The paper contains other points which will doubtless be of particular interest to city and street engineers.

There is excellent opportunity for effective professional work in the field which the new Structural Association of San Francisco purposes to cultivate. This very young but active engineering society works under conditions peculiarly favorable to success. Located immediately on the ground where vast numbers of engineering and architectural structures went down before the attack of earthquake and fire, it has ample store of experience upon which to draw for its discussions. And, on the other hand, with most of its members engaged in the extensive work of replacing the ruins by new and more resistant constructions, it has a most direct incentive toward formulating practical conclusions and applying these in the reconstruction. That incentive is of the utmost value; it compels results. Discussions of the question, for example, of how to make steel-frame structures safe against damage by earthquake motion are likely, in spite of their wide theoretical interest, to remain on a merely academic plane except where, as in San Francisco, the compelling spur of necessity drives toward a speedy solution of the question. Of course, even under the pressure of this necessity, difficult questions such as this one may be solved in but a haphazard fashion, or may be slighted or conveniently forgotten. But it is clear that their conscientious solution in the present conjuncture is a professional duty, and upon the Structural Association of San Francisco devolves the main responsibility for furnishing both the stimulus and the opportunity to fulfil this duty.

The first few months' work of the Association gives good promise that this responsibility will be fairly met. Papers and discussions have brought before it numerous records of experience and opinion concerning details of structural and fireproofing design, the atmosphere of opinion and preference has been cleared, and an understanding of the needs of the situation has been reached. Perhaps the most satisfactory single result is the foundation of a Fire Testing and Experiment Station, which is to furnish experimental data on mooted questions. This experiment station has secured the cooperation of the University of California, of Berkeley, whose laboratories will be used for the work while materials and money will come from the Association. A series of tests on "brick concrete," that is concrete made with broken brick in place of broken stone or gravel, is being undertaken by the Experiment Station, in order to determine the efficiency of broken brick for this purpose. The vast quantity of brick debris which the San Francisco ruins can furnish renders such tests of most immediate and practical value. Other experimental studies will, no doubt, speedily follow this one. The huge task of rebuilding the ruined part of San Francisco will thus have the invaluable guidance of a bureau of experimental research and test in solving its many problems. Provided only this Fire Testing and Experiment Station be energetically and conscientiously conducted, it alone gives the Structural Association of San Francisco ample claim for grateful recognition by the profession.

A few days ago the great municipal transportation enterprise of America's metropolis, the New York rapid transit subway, was crippled for a period of twelve hours—half a day—by the flooding of a low-lying section. The flooding occurred at about 7 p. m. of Tuesday, Aug. 7, and between that time and 6 o'clock the following morning three miles of the line were without train service. The serious meaning of the interruption to the population depending on the line for its regular transportation is in striking contrast to the simple, almost trivial, nature of its cause. A short rainstorm of unusual but not unprecedented intensity poured a large amount of street run-off water into an excava-

tion for a fan-house which is being built alongside the subway structure. From this excavation the water flowed into the subway through large openings made in the wall for the connections of the ventilating system. A dead-ended sewer at the same point blew out its end bulkhead and added its flow. Within a few hours there was a foot to a foot and a half of water on the roadbed at the lowest point [the fan-house is located near a depression in the profile of the line, coinciding with a depression in the topography], and the third-rail was well covered. Trains had been stalled some time before, and their passengers scrambled to the station-platforms as best they could.

To call such an accident unpreventable would, of course, be ridiculous; it would be equivalent to asserting either that a new fifty million dollar urban transit line is at the mercy of every half-hour rainstorm, or else that a piece of work like the construction of this fan-house cannot be carried on without exposing the subway to flood danger. Both assertions are preposterous. Yet in the present case a half-hour rain did block train-service, and the work on the fan-house, evidently, was done in a way that did not protect the subway. There was thus a failure to prevent the unpreventable, which is commonly and appropriately called negligence; this negligence is serious in proportion to the seriousness of the result.

It is of no profit here to inquire where lies the formal, that is legal, responsibility for the accident. Conceding that the flood and the tie-up would not have occurred but for the fan-house excavation, and that if the latter had been itself fully protected against flooding the subway would not have been affected, we still must recognize that this point is not of conclusive importance as concerns the interruption of traffic. The final blame for failure to guard the subway train service must rest on the party whose contractual duty it is to provide and maintain the service, in this case the Interborough Rapid Transit Company.

The technical interest in the case lies as follows: It is of the highest moment to engineers whether or not their labors in design and equipment are to be rendered less effective by negligent operation. There is an axiom in the theory of supply undertakings (whether these furnish water, electric current, rail transportation, or what not) that continuity and reliability of service is a large element of value in the product, and that considerable extra expenditure in plant is justifiable for the purpose of lessening the chance of interruption, that is to say increasing the reliability of service. Now, if such an undertaking is operated carelessly, so that the expected continuity of service is not secured, the engineer's whole calculation is upset, and his extra expenditure becomes a waste of money.

A proper view of the cost of interruptions to service, we believe, furnishes the best inducement to care in avoiding them. We refer here to a characteristic difference between public and purely private enterprises. It is quite customary, in both kinds of enterprises, to measure success by net earnings; and by a sort of reversed analogy the negative value, or cost, of an interruption is often measured by the decrease in net earnings which it produces. While this latter may in general be a proper method of estimate for private enterprises, we must deny its applicability to public service enterprises. The loss to the public which an interruption causes is by far the most important item of the cost, and this frequently bears no relation to the revenue loss to the company. The same reasons that make necessary periods of unprofitable service on public-service systems act also to upset any relation between revenue cost and true cost of an interruption. Indeed, a tie-up of service occurring during unprofitable hours may result in a gain of net revenue; but shall it therefore be considered a desirable interruption? Fortunately the views here expressed are quite widely accepted to-day in the practice as well as the theory of semi-public enterprises, and it is permissible to look forward to their universal acceptance. Still there are many individual instances where much narrower opinions prevail, and it is quite possible that the spirit engendered by such opinions may account for many a case of inexcusable interruption of service.

## THE HARBOR OF CHICAGO.

The Chicago River forms the harbor for the great shipping interests of Chicago, but is far from being satisfactory in its accommodation, especially in view of the great increase in the size of modern lake steamers. The river is narrow and winding, with insufficient depth of water for large vessels, and is obstructed by numerous drawbridges, which are a hindrance to both river and street traffic. The Federal Government has deepened and straightened the river at several points, and has decided to establish a depth of 26 ft. of water for a certain distance, which last feature necessitates the lowering of three tunnels now used by the cable railways. Although there is no definite movement for the radical improvement of the harbor facilities, there are two distinctly opposite schemes proposed. The first calls for the abandonment of the river and the establishment of a harbor on the lake front. The other calls for widening of the river to about 350 ft., and is supported largely by those who believe in the possibility and advantages of a "deep waterway" to and through the Mississippi. A prime objection to the first plan is that it would permanently obstruct a large proportion of the lake front, although the city has spent large sums of money in acquiring lake front property and establishing parks and facilities for public use on this most desirable location. It would also bring about an entire change in the city, establishing a commercial and manufacturing district in what is now a residence district. On the other hand, the second project would involve the purchase of large tracts of valuable and costly land along the river, and would perpetuate and increase the disturbance of street traffic by the opening of bridges; at the same time the numerous bridges would continue to delay and interfere with the movements of shipping. There is no prospect of these or any other projects for the general improvement of the harbor facilities being seriously considered within the near future, but we consider the matter of sufficient interest and importance to warrant discussion at this time. In the first place we give below an abstract of a review of the situation, published in the "Real Estate News" of Chicago:

Col. W. H. Bixby, U. S. Engineer at Chicago, advocates a harbor on the lake front and the practical abandonment of the Chicago River. His predecessor, Maj. W. L. Marshall, is charged with having tried to divert navigation to the Calumet River. Mr. Lyman E. Cooley, C. E., champions a Chicago River nearly twice as wide as the present channel. The Real Estate Board urges the improvement of the river in minor particulars, without reference to the feasibility of developing it into a really adequate harbor. The real issue is between a greater Chicago River and an outside harbor on the lake front.

Col. Bixby recently made a survey of the West Fork of the South Branch of the river, pursuant to the Act of Congress of March 3, 1905, for the purpose of investigating the feasibility of establishing therein a 21-ft. channel. He estimated the cost of enlarging the West Fork as far as Kedzie Ave. to a width of 200 ft., with a navigable depth of 21 ft., at $896,000. He recommended the prosecution of the enterprise provided the necessary land was donated, but expressed some doubt whether the improvement of this fork (which is really little more than an extended private slip) ought to be undertaken by the Government at all. Incidentally he gave expression to pronounced views about the relative merits of an outer and an inner harbor.

The U. S. Board of Engineers for Rivers and Harbors visited Chicago and held a public hearing March 12, 1906. In view of the local character of this channel and the large cost of the projected work, the Board disapproved Col. Bixby's recommendations and reported adversely to any improvement whatever of the West Fork by the United States Government. As to Col. Bixby's views we let his report speak for itself. This is what he says of an outer harbor:

The harbor of Chicago, to be free of access to boats, should properly be located on its lake front and not eight miles inland, beyond more than 25 bridges, which must be closed fully half the time in order to accommodate the already congested, still rapidly growing, and absolutely necessary surface travel of people, teams, railways, elevated roads, freights, expressages, etc., pouring into and out of the business center of Chicago from before sunrise to nearly midnight each day. Under the laws of Illinois the submerged lands on the Lake Michigan shore belong to the state for public purposes alone, and under special acts of the Legislature large areas of the lake front are already being reclaimed from the lake and being converted into public parks. It would be practically practicable and far more reasonable to convert the public harbors, docks, slips, etc., so fast and so as harbor facilities are needed—in the same way as was done at Marseilles and other large commercial ports of Europe on the Mediterranean—so that boats could reach their docks without the delays of the bridge passages, which latter have already commenced to limit the available capacity of Chicago River as a commercial port.

Such harbors would be of such public character as to be clearly entitled to federal assistance. I feel sure that some day such harbors will become necessary to the complete commercial development of Chicago as a lake port, and that it will be found far more practicable to distribute freights by sunken, surface or elevated roads from the several stories of warehouses or docks on the lake front than it will be to carry these same freights eight miles up the Chicago River through more than 25 bridges, each of which may be available for opening only at intermittent intervals amounting to a total of possibly not more than four to six hours in all each day during daylight. Unless the river delays can be avoided the boat commerce is very liable to go elsewhere, as it is already doing to some extent. If for its own benefit and to conserve vested rights of its citizens and corporations, a lake front city prefers to abandon its natural water frontage and to dredge new artificial harbors inland the latter work may reasonably be regarded as of nature more municipal or local than federal.

Beyond all question the construction of an outer harbor is an enormous undertaking, and a hundred objections can be made to the feasibility of the enterprise, some of which are unanswered, if not unanswerable. It should be looked at in its large outlines first. Where shall the harbor be? Col. Bixby concedes that under the decisions of the courts it cannot be opposite Grant Park, between Randolph and 12th Sts., and he would therefore have it extend south from 12th St. to Jackson Park, connecting with the business center by underground or surface lines of transportation. The stupendous nature of such an undertaking is at once apparent. It might well ruin a large part of the South Side for residence purposes, and no means of communication could make it in this generation really accessible to the commercial district as now located.

Everybody knows the drawbacks to the use of the Chicago River as a harbor for commerce, but in the opinion of Mr. Cooley and many others it furnishes the best and only practicable solution of the problem. The river will have to be widened, not to 200 ft., as has been proposed, but to 350 ft., before adequate accommodation can be provided. It is not necessary to do everything at once. A 200-ft. channel may serve for the time being, but all improvements should be made with a view to the ultimate establishment of a 350-ft. waterway. Mr. Cooley estimated in 1901 that the channel could be widened to 350 ft. as far as 16th St. at a cost not exceeding $24,000,000.

Mr. Cooley draws a nice distinction between navigation and commerce. It is apt to be taken for granted that when the demands of navigation have been complied with, the needs of commerce will be satisfied. Their interests are by no means identical. Any harbor which is safe and easy of access will serve the ends of navigation, but commerce requires the discharge of freight where it will be absorbed at once in the activities of trade. An outer harbor, or even the Calumet River, might answer the purposes of navigation and yet fail to realize the most vital necessities of commerce. Traffic on the streets is quite as vital a function of the city as either commerce or navigation, and an outer harbor furnishes the only solution for its perplexities. Traffic demands stationary bridges and the abandonment of the river as a main artery of commerce. Vessels must be enabled to discharge their cargoes, but, after all, the main problem is how to reconcile the interests of local commerce with those of surface traffic. Shall the city permanently acquiesce in the obstruction of the streets by open bridges, or shall it remove the commercial districts bag and baggage to the lake front?

One point which is overlooked in the above review of the arguments for and against the inland and lake-front locations for the harbor, is that of the relation of the Chicago Drainage Canal to the city and harbor. This canal, while built primarily for the removal of the city's sewage, has always been regarded secondarily as a prospective route for navigation, and there is already a definite project for the establishment of a 14-ft. channel from the present end of the canal to the Mississippi River at St. Louis. There is also a vague idea of a deep-water channel throughout the entire course of the Mississippi River from St. Louis to the Gulf, but this we need not now consider. All bridges over the Drainage Canal have been built as drawbridges, with a view to future navigation, and already some amount of water frontage on the canal has been leased for com-

mercial purposes, while the Drainage Board has recently taken steps to provide additional dock front accommodation by awarding a contract which will ensure the removal of large quantities of stone from the "mountain ranges" of excavated debris or spoil which now line the banks of the canal. If the canal is ever to be utilized for navigation, the abandonment of the river is out of the question.

It is true that the Calumet River is already extensively used for harbor purposes, and has for some years had a greater depth of water than the Chicago River, while the Calumet feeder to the Drainage Canal (which is authorized but not yet commenced) has been suggested as a route for navigation which would avoid the troublesome passage along the Chicago River through the city. But the abandonment of the Chicago River for harbor and navigation purposes seems most improbable. As far as the physical condition of the river is concerned, it is capable of considerable improvement, apart from the matter of radical enlargement. It has been to a large extent neglected, obstructions and encroachments have been permitted or overlooked, and several collisions between ships and bridges have been due more or less to difficulties in navigation and to the handling of the bridges by incompetent men (this last being a periodical scandal in the city administration).

Even if the river is necessarily perpetuated as a route for navigation, however, this does not necessarily imply that it must provide all the facilities of a harbor. In fact, instead of the problem being as to whether a river harbor or a lake-front harbor is the best, it may resolve itself into the question of how best to provide harbor facilities (with the necessary railway terminals and other accessories) both along the river and upon the lake front. This being the case, it would, of course, be desirable to have the lake-front harbor located directly at the mouth of the river, instead of at a distance therefrom, although the latter arrangement is suggested in Col. Bixby's report. There is already an outer harbor for anchorage, protected by breakwaters extending beyond the mouth of the river, and while the lake front south of the river is not available (having been set aside for public use as the site of the new Grant Park), it may be that sufficient harbor facilities could be provided north of the mouth of the river. The development of the Drainage Canal for navigation may be a matter of the distant future, but it is very evident that it is a possibility to be seriously reckoned with in any comprehensive project for the improvement of the harbor facilities of Chicago.

While it is true, as already noted, that the subject of an extensive improvement or revision of the harbor facilities is not now receiving any attention on the part of the city, it is desirable that this subject should receive careful consideration before any congestion of traffic or other difficulties demand prompt measures of relief which may be hastily undertaken without due regard to the problem as a whole. It is safe to say that no thorough investigation as to the future needs of Chicago as a port and harbor, and the best means of providing for these needs, has ever been undertaken. Minor improvements have been made here and there (both by the city and the government) to meet immediate local necessities, and several ambitious projects have at different times been set forth by those more or less interested in their promotion. But a thorough and impartial expert review of the entire situation, with its various conditions, has yet to be made. In view of the growth in the city's commerce and shipping business, the increase in the size of lake steamers and the numerous minor difficulties and perplexities already experienced, it would seem that the present time is appropriate for such a study. This should be in the hands of competent and disinterested authorities, and might be made on behalf of the city alone, or jointly in behalf of the city and the railway, shipping and commercial interests. One of the great faults of our municipalities, and also of those engaged in the development of private transportation facilities, is the failure to look well ahead and to give due weight to the possibilities or probabilities of the future. The possession of an ideal and comprehensive definite plan, even though its possible execution may be remote, is advantageous in many matters concerning city development; it tends to concentrate and combine the ideas of those who see mainly one phase of the subject, and may often prevent future waste of money and energy in rectifying the results of haphazard and piecemeal improvements.

## LETTERS TO THE EDITOR.

### A Scale for Computing Widths of Railroad or Other Cuts and Fills.

Sir: I enclose a blue-print of a simple device which I find to be of convenience and value in connection with railroad cross-sectioning. The idea is to be able to find the "distance out" from center without having to first

A Scale for Computing Widths of Cuts and Fills.

add ½ road bed to 1½ × cut or fill. This print is for a 14-ft. road bed with slope of 1½ to 1. To obtain the distance out, read opposite a given cut which is scaled on the right-hand side of scale. Respectfully,

J. R. S.

Champaign, Ill., July 23, 1906.

### Solving Right Triangles of Flat Slope.

Sir: In the article appearing in your correspondence columns, May 3, 1906, "Solving Right Triangles of Flat Slope," it appears to me unfortunate that Mr. Fuller should have neglected all the terms of his correction, except the first one. The other terms, in their order, are sometimes appreciable and can readily be obtained *if they are considered as functions of each other.*

In a right angled triangle, let

h = hypotenuse, b = base, p = perpendicular

$$\text{then } b = \sqrt{h^2 - p^2} = h - \tfrac{1}{2}\cdot\frac{p^2}{h} - \tfrac{1}{8}\cdot\frac{p^4}{h^3} - \tfrac{1}{16}\cdot\frac{p^6}{h^5} - \tfrac{5}{128}\cdot\frac{p^8}{h^7} \quad (1)$$

$$\text{or } b = h - A - B - C - D$$

$$h = \sqrt{b^2 + p^2} = b + b\,\tfrac{1}{2}\frac{p^2}{b} - \tfrac{1}{8}\cdot\frac{p^4}{b^3} + \tfrac{1}{16}\cdot\frac{p^6}{b^5} - \tfrac{5}{128}\cdot\frac{p^8}{b^7} \quad (2)$$

$$\text{or } h = b + A - B + C - D$$

(Formula (1) should agree with Mr. Fuller's, but his signs are not correctly given.)

Now in formula (1), A, the first correction, is equal to $\frac{p^2}{2b}$, $B = \frac{A^2}{2h}$, $C = \frac{AB}{h}$ and $D = 5\frac{B^2}{2h}$

In formula (2) the corrections are likewise obtained, by using b as a divisor.

The writer has found the succeeding terms B and C to be of use, especially when testing the sufficiency of the simple rule quoted by Mr. Fuller, and in making sure that the slope of the triangle is in reality not too great to admit of the use of the correction A, simply. Then "square your first correction and divide by twice the slope" will give the value of B, the second, and generally a sufficient, approximation. As an example, under (1), let h = 50, p = 10.

$$A = \frac{10^2}{2\times 50} = 1 \quad B = \frac{1^2}{2\times 50} = 0.01 \quad C = \frac{1\times 0.01}{50} = 0.0002$$

$$\text{and } D = 5.\frac{0.01^2}{2\times 50} = 0.000005, \text{ hence,}$$

$$b = 50 - 1.010205$$

As an example under (2), with base = 50 and perpendicular = 10, the quantities A, B, C and D will be numerically as above, but will have alternately plus and minus signs.

$$h = 50 + 1 - 0.01 + 0.0002 - 0.000005, \text{ or}$$
$$h = 50 + 0.990195$$

The slide rule is especially well adapted for the computation of the corrections A, B, C and D, or as many of them as may be needed.

Distances taped with a 50-ft. tape, with levels taken at each tape end, are thus quickly and very precisely reduced to the horizontal, even in extremely rough country.

Very truly yours,

Horace Andrews.

125 Lancaster St., Albany, N. Y., July 23, 1906.

### Another Method of Computing Railroad Cross-Sections.

Sir: In your issue of June 28, p. 723, is described a method of computing excavation and embankment. Below is a formula which I have derived for figuring the area of any cross-section of such an excavation or embankment when the line of ground slope does not intersect the plane of the roadbed.

In the figure (p. 723) let B = the angle that the ground slope makes with the horizontal, C = the angle that the side slopes make with the horizontal, and w = the width of the roadbed. Also let A, p, h and Q have the same values as in Mr. Sloan's method; that is, A = area of cross-section; p = center height of cut or embankment; h = height from surface of roadbed to intersection of side slopes (produced); Q = area of triangle enclosed between roadbed and side slopes produced. Then

$$A = \frac{(p+h)^2(\cos 2B + 1)\,\tfrac{1}{2}\sin 2C}{\cos 2B - \cos 2C} - Q.$$

In a series of cross-sections the values of C and w change, if at all, only at intervals; while the values of B and p depend upon the natural features of the ground, and may change continually from section to section. Hence C and w (and consequently h and Q) may be considered constants, and B and p may be considered variables.

Let C = 32° and w = 24 ft. for a series of sections; the computation, which needs to be done but once for all sections of the series, is:

$$\log \tfrac{1}{2}w = 1.07918$$
$$\log \tan C = 9.79579 - 10$$
$$\log Q = \begin{cases} \log h = 0.87497 = \log 7.498 \\ \log \tfrac{1}{2}w = 1.07918 \end{cases}$$
$$1.59415 = \log 89.98$$
$$\log \sin 64° = 9.95366 - 10$$
$$\log \tfrac{1}{2} = 9.69897 - 10$$
$$\log \tfrac{1}{2}\sin 2C = 9.65263 - 10$$
$$\cos 64° = .4384$$

Then h = 7.5 ft., Q = 90 sq. ft.

Log ½ sin 2 C = 9.65263 − 10 and cos 2 C = .4384.

If for one of these sections B = 3° 35′ and p = 17.3 ft., the computation for its area is:

| | |
|---|---|
| p = 17.3 | log ½ sin 2 C = 9.65263 − 10 |
| h = 7.5 | log 1.9922 = 0.29933 |
| | 2 log 24.8 = 2.78890 |
| p + h = 24.8 ft. | colog .5538 = 0.25665 |
| B = 3° 35′ | 2.99751 = |
| 2 B = 7° 10′ | |
| cos 2 B = .9922 | log 994.3 |
| cos 2 C = .4384 | Q = 90. |
| cos 2 B − cos 2 C = .5538 | A = 904. sq. ft. |

so that the area of this section is 904 sq. ft.

If B = 2° 5′ and p = 33.6 ft. in another section,

| | |
|---|---|
| p = 33.6 | log ½ sin 2 C = 9.65263 − 10 |
| h = 7.5 | log 1.9974 = 0.30047 |
| | 2 log 41.1 = 3.22768 |
| p + h = 41.1 ft. | colog .5590 = 0.25259 |
| B = 2° 5′ | 3.43337= |
| 2 B = 4° 10′ | |
| cos 2 B = .9974 | log. 2712. |
| cos 2 C = .4384 | Q = 90. |
| cos 2 B − cos 2 C = .5590 | A = 2622. sq. ft. |

the area of the section.

The formula can also be written thus:

$$A = \frac{(p+h)^2\cos^2 B \sin 2C}{2\sin(C+B)\sin(C-B)} - Q.$$

Will you please give me your opinion of this formula?

Very truly yours,

Elbert O. Brower.

Southbury, Conn., R. F. D., No. 2, Aug. 3, 1906.

## More Concerning the Right of an Engineer to Have the Best Offer for His Services.

Sir: There has been much written for your columns during the past few years regarding the low salaries and abuses suffered by the civil engineer.

At one time it was suggested, by some one, that we organize some kind of a brotherhood for the protection of ourselves, and demand a compensation for our services commensurate with that obtained by men in other professions. This was objected to by some because, in their opinion, it did not look "professional" for the dignified engineer to name the price of his services before performing the work; in other words, he should live a life of poverty, and sacrifice comfort for false pride.

The subject of monthly salaries, with those employed by corporations, was also freely discussed, in which the engineer's salary was compared with that of the "hod carrier." The debate, I think, was won by those who favored upholding false pride at the expense of salaries, and the man who has spent the best years of his life and several thousand dollars, together with many sacrifices and privations, in preparation for his life work, expecting to be able to command a salary which might enable him to live comfortably, now finds himself receiving nearly the same salary as he received ten years ago clerking in a store or perhaps working at the carpenter trade, trying to save up enough money to put himself through college.

The man who thinks it "unprofessional" to organize the engineering profession into a body having at heart the interests of their fellow man, has probably not been face to face with the problems which have confronted some of their less fortunate brethren. There are to-day large railroad systems employing good instrumentmen, who have had several years of experience in addition to a thorough technical training, at considerably less than $100 per month and no expense account while away from headquarters.

The writer has recently been told by a man employed in that capacity that all his traveling expenses had been cut out. Which one of these "professionalites" would like to sit on the end of a wet cross-tie and eat his cold lunch in sight of the "hod carrier" who is enjoying at least a good fat dinner pail?

I fully expect some one of my brethren, whose false pride overbalances his bank account, to say in a following issue that it is a plain case of "sour grapes," but such is not the case. The writer, after a good technical training, began at the bottom, where every boy should begin. He has never used his friends to pull him along, although a "pull" is sometimes a good thing, especially with a railroad company. He has won every promotion through his own merits.

The cases cited in your issues of June 21 and July 12, 1906, in my mind, are only too true. I could name instances where some things have been done which would closely resemble the cases cited.

To the young engineer I would say, give your employer the very best service within your power, whether you are being paid what you are worth or not. Ability will be recognized some time, even if you continue with your present employer, who may refuse to increase your salary because he thinks you are afraid to leave. There is more truth than poetry in the old saying that "you can't keep a good man down," and I shall never forget these words as being those of my superior officer in the beginning of my engineering career.

Next to this is "all things come to those who wait." But, especially with the railroad company, do not wait too long. More men have forged their way to the front by accepting a better offer, than by hanging on for their turn to come next with the present employer. When you are confident that you are worth more money than you are receiving, ask for a raise. Your superior who recognizes your ability will also know that your ambition will eventually lead you to a better position. Nine times out of ten if you are deserving you will get it. Very few men are so narrow minded as to try to keep you if you can do better elsewhere, even if they are inconvenienced by your leaving. As a rule, engineers are liberal minded. It is usually the engineer who occupies a high position and who in trying to make a record for himself, who begins reducing expenses by cutting salaries of his subordinates.

It has always been the policy of the writer, when grossly mistreated by a superior, to quit, regardless of a new position in sight. Of course this can be carried to extremes, but he has never yet had occasion to regret having taken any such action, and has never yet been "down and out" looking for a job.

If engineers, in general, would show a spirit of independence—together with all due respect for a superior—rather than the spirit of dependence, the engineering progession would be greatly benefited, and we would win the first battle towards placing ourselves in position to command compensation for our services commensurate with that of other professions.

Yours truly,
Another Railroad Civil Engineer.

New York, July 18, 1906.

## Charges for Engineering Services.

Sir: There has been considerable discussion in your columns about wages or salaries paid to engineers. I would very much like to see some statements regarding the prices which engineers in private work charge for various services, such as bridge and building steel design and detailing, sewer design and superintendence during construction, railroad work and surveying. Or, in other words, what would be the proper charges for such services by an engineer just opening an office? The prices probably vary according to locality, but I would like expressions from all over the country.

Also where should a young man, with a technical education and a good experience covering eleven years, locate, east, west or south, city or small town? How soon reasonably should a man succeed in getting a living income? What maximum could he reasonably expect to attain?

Some one in your paper said $4,000 was an average income for an engineer. Is not that too large? My own knowledge of salaries paid engineers would lead me to believe $2,000 a more accurate figure; or, if we eliminate all engineers of less than ten years' experience, the average would be about $2,500 for salaried men.

The desired information may perhaps be considered private and stock in trade, but I hope some answers will be forthcoming.

Respectfully,
C. L. H.

Nebraska, Aug. 5, 1906.

## Coal Tar Paints.

Sir: Referring to the editorial comments in your issue of July 12, 1906, concerning the article on "Coal Tar Paint," by Mr. A. C. Cunningham, I have waited a couple of weeks with the hopes that some one would save me the labor of calling your attention to the fact that your comments on this article might lead some of your readers to considerable expense. While we have great respect for your knowledge on engineering matters, it is clearly evident that you are hardly up to date with regard to the paint question; otherwise you would not suggest that a steel roof or a corrugated iron siding which is exposed to the sun could be covered satisfactorily with a paint made from coal tar or any similar article, such as pitch or asphalt. It is a well known fact that none of these, and especially coal tar, will stand sun exposure, although they all have their value when used in paints that are to be applied for underground or under water locations.

The technical paint maker of to-day is a well advanced in his particular line as is any other manufacturer. Coal tar has been presented to him for years past, and while we do not attempt to say it never can be made into a satisfactory paint, we do say that up to the present time it has never given good results in a paint that has to stand sun or weather exposure.

The writer remembers very distinctly when a majority of gas holders in this country were painted with "coal tar," but to-day the gas companies are fully persuaded of the fact that it is a very poor article to use on their holders. It is only used on old holders that have had tar on before. We receive almost every week letters from various companies asking us if it is not possible for them to paint over "coal tar" with our gas holder paint, but we have to say regretfully that unless the metal is cleaned and all "coal tar" removed we cannot furnish any paint that will stand over it. As the labor would be considerable to do this, as a rule, they continue to repaint their old holders (very frequently) with "coal tar."

There is no question but what the acids in coal tar will have an injurious effect on iron or steel, unless the tar is carefully boiled to remove the acids.

We find in Mr. Cunningham's article several statements which do not seem to agree with other records. With reference to his formula:

> Red lead 100 lbs.;
> White zinc 20 lbs.;
> Raw linseed oil 5 gals.;
> Turpentine Japan 3¾ pints;

we would call attention to a report in Mr. M. P. Wood's book on "Rustless Coatings," page 55, where he states that

> The United States and other governments have favored in the past a mixture of two or three parts of red lead and one of zinc oxide for the protective covering for lighthouses and seacoast iron structures. These coatings are harder than red lead alone, and better resist the action of salt-water spray, fog, and the abrasion from the sand-blast usual in such locations. But the result of some thirty years' experience with these mixtures has led to their abandonment for the reason that the oxide of zinc in the coating changed to a carbonate of zinc, and by its increase of volume disrupted the dried coating, exposed the ironwork, and the increase in the corrosion was markedly greater than with red lead alone, or red lead and silica, or red lead and graphite coatings.

We also do not understand why Mr. Cunningham advocates the use of raw linseed oil on account of the intensely drying properties of the red lead, and then proceeds to add 3¾ pints of turpentine Japan to 5 gals. of raw linseed oil, which is as large a proportion of Japan as is generally used in paints which do not contain red lead. He is somewhat in error in stating that boiled linseed oil is used in ordinary paints. No intelligent paint maker uses boiled linseed oil in any of his paints (unless his customer specifies the use of it), as he knows that he can get better results by the use of raw linseed oil with a proper proportion of the special dryer needed for the particular pigment used. A great deal depends upon using the right drier in combination with certain pigments, and here is where the amateur paint maker usually falls down the hardest.

Yours truly, Frank P. Cheesman.

100 William St., New York, July 27, 1906.

[The best service that the author of a letter or the editor of a journal can render is to stimulate impartial discussion from persons of experience. Mr. Cunningham's paper, it appears to us, was a commendable attempt to put on record, for information and discussion, his experiences with coal tar and other paints. Our comments were designed to call attention to Mr. Cunningham's article and suggestions, both for the sake of giving his experience and suggestions wider publicity and in the hopes of eliciting discussion. We are pleased to record the first known results of our comments, even though the author of the foregoing letter is disposed to argue that we would do better to leave the discussion to the paint men. As to the latter suggestion, however, an analysis of our comments will show that they consisted chiefly in (1) calling attention to the effect that where the labor expense of painting is a minor element in the cost it may be advisable to use a cheap paint, even though frequent repainting is thereby made necessary; and (2) in stating that the possibilities of using so cheap a material as coal tar are worthy of investigation.

In accordance with our custom, proof of Mr. Cheesman's letter has been submitted to Mr. Cunningham. His reply is given below. Following his letter is one from Mr. Alfred E. Forstall, lately Secretary of the American Gas Light Association, answering inquiries of ours regarding the present practice of gas companies in the matters of using coal tar for painting gas holders and of using coal tar as fuel—the latter having been mentioned by us, in our issue of July 12, as proof of the large quantities of coal tar available for paint.—Ed.]

Sir: Referring to Mr. Cheesman's remarks on my article, "Coal Tar Paint," I beg to submit the following reply:

Mr. Cheesman discusses the matter as if the paint was simply raw coal tar. I fully agree with Mr. Cheesman that anyone who has used raw coal tar on a surface of any importance will regret it. It forms a sticky, non-drying coating of unsightly appearance, which will strike through any paint that is placed over it, and which it is almost impossible to remove after once being applied.

The mixture of coal tar, kerosene oil and Portland cement has, however, entirely different properties. In appearance it resembles a high-grade asphaltum paint, and has none of the objections to raw coal tar that Mr. Cheesman mentions, except that of intensely adhering to the surface to which it is applied—if that is an objection. Right here it might be well to call attention to the fact that all "gas tars" are not necessarily "coal tars."

It would be a matter of regret if any of your readers should get themselves into trouble and expense by using coal tar paint where white lead or varnish was more suitable; but if the experience of others coincides with mine, no one in these days will extensively use any new paint without first satisfying themselves that it has some value.

In your editorial comment you refer to the vast area of unprotected metal sides and roofs in this country which stand unprotected because they have not sufficient remaining value to be cleaned and painted with a high-priced paint. Here is a field for coal tar paint, and two or three dollars will make the test.

Regarding my formula for red lead paint: if one chooses to wait longer for the drying, the Japan dryer may be omitted; the amount used, however, will not "burn" the paint and gives quicker results.

In red lead paint I have tried red lead and raw linseed oil alone. To get a mixture that covers well and will not crawl and separate, it takes from 25 to 30 lbs. of lead to a gallon of oil. The appearance of this mixture when applied is splendid. It has little adhesion, however, and in a short time can be pulled off in large patches. The white zinc stops this crawling and allows the reduction of red lead to a point where good adhesion

...be had. Zinc oxide may in the course of time turn ...carbonate of zinc, as Mr. Cheesman quotes, and if ...n is the case the user has the choice of two evils.

...is to be presumed that Mr. Cheesman uses raw oil ...dryers in ordinary paints instead of boiled oil, be...se genuine boiled oil is a thing of the past. We are ...led to believe that the chemist has become a more ...portant factor in the manufacture of raw oil than the ...ments of time and patience.

...ted lead paint has never had the support of the paint ...nufacturer, for the very good reason that it is out of his sphere. Coal tar paint will have still less, for it is not only out of his sphere, but exceedingly low-priced.

Yours truly,

A. C. Cunningham.

Washington, D. C., Aug. 2, 1906.

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Sir: I think that gas companies are to a great extent abandoning the use of coal tar as a gas holder paint, but believe that this is more because of the somewhat unsightly appearance of the surfaces that have been painted with tar, as it is ordinarily employed, than because the tar, even when applied without any particular care, has failed to protect the metal. Coal tar applied cold cannot be spread in a thin coat, and after repeated applications of it holders may be covered with a layer nearly ¼-in. thick of what is practically pitch, all the light oils having been driven off by the heat of the sun. This thick layer cracks badly and is very unsightly, but in cases where it has been scraped off under my supervision the priming coat of red lead has been found in perfect condition on the sheets of holders that were 20 years old and had never been painted with anything but coal tar after the priming coat of red lead.

It is very easy to bring tar into a condition in which it can be applied in a thin coat which will harden very quickly and when hard resembles graphite paint. When thus prepared and used it affords almost perfect protection for iron that is exposed to the severe conditions of being alternately wet and dry. In my practice the coal tar was boiled until all the water was driven off from it, this being shown by the cessation of the foaming produced by the evaporation of the water. A little quicklime was added, and the tar was then ladled out from the large kettle into the paint pots, in which it was thinned to the proper consistency with light tar oils purchased from a tar distiller. The mixture was used hot, and preferably on iron that had been heated by the rays of the sun, and the results obtained were very satisfactory.

I do not consider myself fully posted as to what gas companies are doing in the way of burning coal tar, but I do know that quite a number are using as much of this tar as possible for fuel, and believe that it would probably be to the advantage of others to adopt the same practice, since the present market value of coal tar is less than the fuel value as compared with the prices which other fuels bring.

Alfred E. Forstall.

58 William St., New York, Aug. 2, 1906.

## Against the Templet System of Fabricating Steel Work.

Sir: I have read with much interest the articles of Mr. Jno. C. Moses, M. Am. Soc. C. E., published in your journal of March 22 and 29, and April 5, 1906, entitled "Shop Hints for Draftsmen." Mr. Moses shows [inset sheet and p. 327 of Eng. News of March 22, 1906] a drawing of a double-track plate girder bridge, three girders, iron floorbeams and stringers—a very elaborate drawing, showing every rivet, every detail and distance marked in plain figures. If I was in charge of an engineering office making drawings and plans for contractors, as an engineer I think I would make my drawings as elaborate as Mr. Moses has made the drawings he has shown, and charge a good fee for my engineering ability. On the other hand, if I was chief draftsman for a bridge shop or any other kind of a structural shop, I would not permit such elaborate drawings made for workingmen to work from. It is a waste of time.

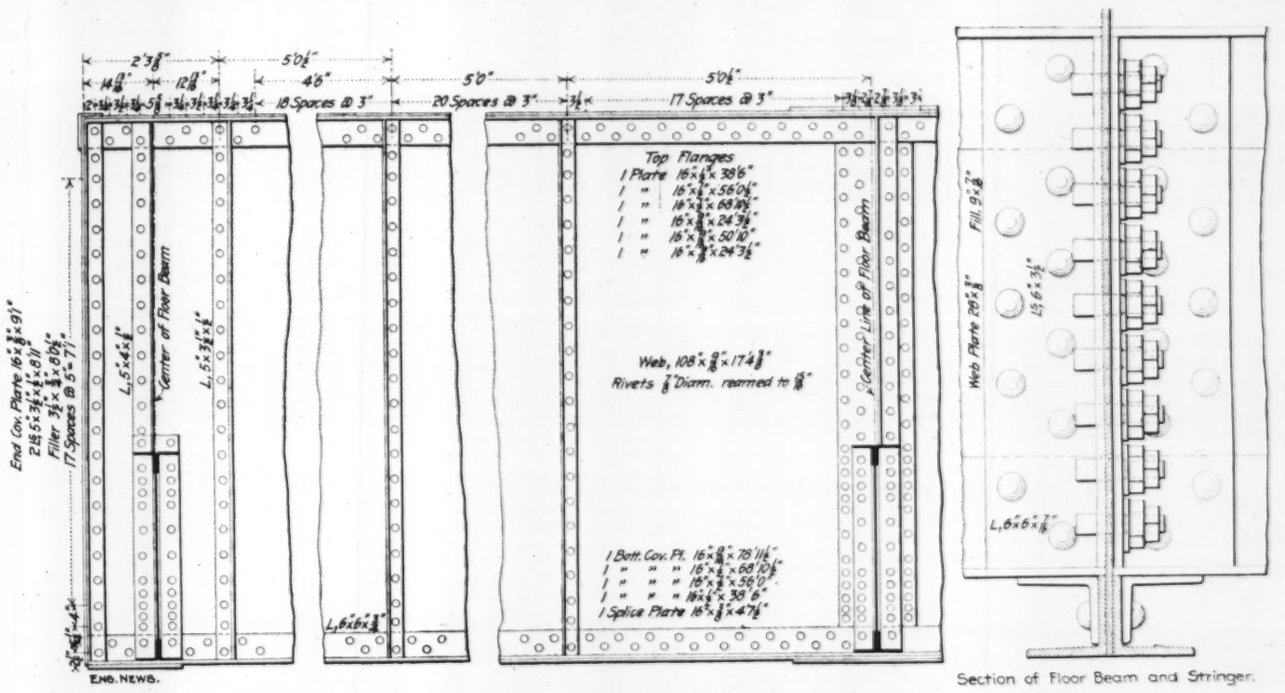
I beg to reply to Mr. Moses' articles through the columns of Engineering News as a practical experienced manager of structural works, both in the drawing-room and in the shop and field, in a manner I trust not to criticise Mr. Moses' designs or his understanding of how shop drawings or shop work should be done. My object is to point out the delays and mistakes that occur in many manufacturing plants, in my judgment, at the expense of the shop.

Preparing drawings for structural work or any other class of work, for shop men to follow, means they should be made as simple as possible, and at the least expense. This can be done by a competent draftsman. If he has no shop experience, he should spend one year at least in the shop before he is taken in the drawing-room. If the management wants a picture made, don't send it to the shop for workmen to follow.

The reader will note in Mr. Moses' drawing the number of fractional spacings as 3 3-16 ins., 3 5-16 ins., 3 7-16 ins., 3 9-16 ins., 3 13-16 ins. and 3 15-16 ins. running all through the work, not only in the girders, but in the floorbeams and stringers, and also the amount of work there is shown by this design. Had Mr. Jno. C. Moses set to work to design the most expensive piece of shop structural work he could dream of, I think he hit the nail square on the head in the drawing he shows in connection with his articles. I don't question for one moment that the design and all the rivet spacing is correct technically. For expensive shop workmanship, I have never seen a piece of structural work to equal it. But for economical shop work there is not a rivet space in the job that should be less of a fraction than ⅛-in. Mr. Moses is a firm believer in wood templets. I don't see how he could build such a bridge as he shows without a first-class templet maker and a full set of wooden templets and stick religiously to the drawing. A structural shop can be run without a single templet maker, I don't care how complicated the drawings are or what the equipment of the shop is.

The attention of the reader is referred to the drawing of a plate-girder attached [Fig. 1 herewith]. The drawing shows the end sections of a plate-girder bridge, single track, which is 99 ft. 5 ins. out to out, 9 ft. 0 ins. deep, with iron floorbeams and stringers, designed and built by a first-class bridge works of long standing for a first-class railroad using the heaviest rolling stock. Look it over carefully and see if you can find one single fractional spacing less than ⅛-in. in the job. You will find all the rivets are in line longitudinally and transversely: rivets all one size. Where is the bridge shop that wants a wooden templet to prepare this material for the punches?

Follow me and I will show you how to lay off this work without a single wooden templet. The web sheet is 108 ins. × 9-16-in. × 17 ft. 4⅝ ins. This is the first piece the layer-off wants. The first line of rivets is 2½ ins. from the edge of the plate, next line 2 ins., the next 3¼ ins., the next 4 ins., then come 17 spaces 5 ins. The top spacing is the same as the bottom. Have a fine fish-line for a chalk line and strike your first line 2½ ins. from the edge of the plate and square two right angle lines, one at each end of the plate, and on these lines lay off the spacing I have named with a steel tape. This done, strike this line with your chalk line, have a piece of band iron about 1¼ ins. wide × ⅛-in. thick clean and




Section of Floor Beam and Stringer.

FIG. 1. DRAWING OF END SECTION OF PLATE GIRDER THROUGH BRIDGE, ARRANGED FOR ECONOMY OF LABOR.

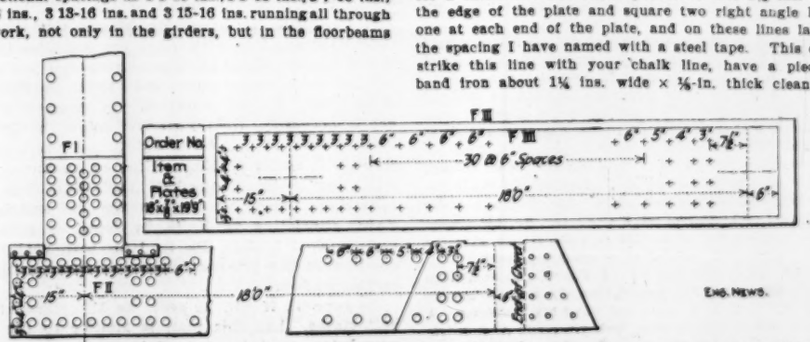



FIG. 2. END BOTTOM CHORD, KENTUCKY RIVER CANTILEVER BRIDGE. DRAWING AND PUNCHING CARD.

straight full length of your plate, clamp it and your steel tape and weight it to bring it taut, and with a sharp slate pencil lay off your spacing as indicated on drawing and project your lines across the plate. When this plate is punched it is a templet for four plates. Follow up with the balance of the web sheets, of which there are twelve in the bridge. You have only three plates to mark off as I have described. The balance of the material in this bridge is all laid off in the same manner.

The bridge has two girders, eight floorbeams, ten stringers, a few brackets and lateral bracing. I will wager that a first-class layer-off at $3 per day and his help at $1.50 per day will lay off the entire material for this bridge in two weeks at a cost of $54. It will take a templet-maker at $3 per day and a second man as helper at $2 per day, three weeks to make all the wooden templets, at a cost of $90, say nothing about the cost of the lumber used. Will a layer-off do his work in any less time by having the wooden templets? No. Now you have $144 with wooden templets against $54 without wooden templets. I think this statement—and it is a fact—kills the wooden templet theory.

I will go a little further and say, the work can be done without either layer-off or templets and much better if you have the equipment in your shop that you should have.

The spring of 1875, 31 years ago, found the writer at Edge Moor Iron Works, Wilmington, Del., in the position of shop superintendent. The owners of the company were the late William Sellers and brother. The plant was new and was equipped with the most modern tools for structural work. In the shop were two multiple punches that would take between housings 72-in. plate, with spacing table 70 ft. long spacing down to ¾-in., an angle shear mounted on compound base [you could cut a bar of structural iron at any angle without moving the bar], a chord borer that bored the pin-hole and faced the end at the same time, and some punches fitted up to cut lattice bars as described by Mr. Moses. In addition to a large amount of bridge work in the shop, the company had the contract for fabricating all the iron work for the main exposition building for the Centennial held in Philadelphia, Pa., in 1876, a building one-half mile long and over 500 ft. wide. There was not a templet-maker or a layer-off employed in this shop.

This may sound a little "fishy" to our young men of to-day who are managing structural shops. Nevertheless, it is a fact. The gentleman who was chief engineer of Edge Moor at that time is alive to-day and will vouch for what I write.

All drawings for work done in the shops of the Edge Moor plant during my time of service with them were made to conform to the shop tools: I mean in the rivet spacing. All draftsmen working at Edge Moor had the privilege to spend at least one hour each day in the shops and familiarize themselves with the shop system of doing work. When a set of drawings was finished, an expert engineer carefully checked them. From him the drawings were turned over to a draftsman who was familiar with all the tools in the shops and knew how the material would go through the shops. He made "punching cards." Each card was marked and corresponding marks were put on the drawing locating the piece. When the punching cards were all made, the drawings and cards were sent to the shop superintendent. He gave out the cards as he ordered in the material. Drawings were retained in his office for reference.

All the work in Edge Moor shops was done on the system I have explained. About the same time the fabricating of the material for the Kentucky River viaduct, which was illustrated in Engineering News of March 23, 1905, p. 312, was in the shops. Not a single templet was made for any part of it or a layer-off employed on the job. I have in my possession a complete set of blue prints of this viaduct, and attach a sketch [Fig. 2] of an end post and end bottom chord with a punching card for an outside plate of bottom chord to show the reader how simple a punching card is and how much easier it is to work to than a complicated drawing as Mr. Moses shows. F-1 shows the lower end of the end post, which is a box post made up of plates and angles. F-11 shows bottom end chord. F-111 is simply a piece of brown drawing paper to lay off the punches on and it is the punching card. F-1111 shows the punching for the outside plate that goes to make up the end chord. On the card is marked the Order Number, Item Number of Plate, Number of Plates Required and Sizes of Plates. All the marking on the material is done before it reaches the punches. The material is all stacked in order until all the material is punched and ready for assembling and handled only once. The time is kept by these cards, each class of work separate. By this system you can tell the cost of the job in a short time after the contract is shipped each class of work separated.

January, 1878, the control of the Keystone Bridge Works at Pittsburg, Pa., passed from the original owners into the hands of Andrew Carnegie and his associates. A reorganization of management took place and A. Gottlieb, the Western Engineer, was made President; C. L. Strobel, C. E., was made Assistant to the President and Engineer; Jos. H. Springer, Sr. (the writer), was made Shop Superintendent. A new Board of Directors was elected. The three officers I have named went on the Board. The work and system in use at Edge Moor had attracted the attention of Andrew Carnegie and Mr. J. H. Linville. A resolution was passed by the old board to put the works of the Keystone Bridge Works on a piece-work basis and adopt as much of the system used by the Edge Moor Works as was practical and in keeping with the equipment of the Keystone Bridge Works' shops.

The writer was tendered the position as superintendent and accepted. My instruction was as I have stated above. I found this no easy task to accomplish. Labor unions at that time had a strong foothold in Pittsburg, Pa. This, you well remember, was 28 years ago. In six months the entire plant was on a piece-working basis and without a strike or one hour's trouble with the men. I found at Keystone Bridge Shops a system I was forced for a time to use. A multiple punch of Sellers' make had been installed, but was not in general use. The workmen could see it would take the place of a number of layers-off. Another drawback I was up against: the drawings were not made to match the tools as was the case at the Edge Moor Iron Works. This trouble was soon overcome and a second multiple punch was installed, also a number of other modern tools. Wooden templets were dropped. The layers-off were made heads of assembling gangs. I picked out the best layer-off we had and trained him to make punching cards.

The shop office was the headquarters of the shop superintendent, general foreman, the layer-off to make the punching cards, one timekeeper and two cost clerks, and in one year everything was working to the entire satisfaction of the board. For over eight years this organization I have named managed the work successfully and paid good dividends to the stockholders, and held the blue ribbon for good work, and I say with pride that during the eight years not a single strike occurred in the works of the Keystone Bridge Works.

I want to call the reader's attention to the connection of floor beams to girders in the bridge shown in Fig. 1. You will notice the distance from center to center of holes in end floor beams is 5⅝ ins. and all the intermediate floor beams are 5¾ ins. This is done to avoid mistakes in the field; the web plate of the end floor beam is ⅜-in. and the other $^{7}/_{16}$-in. I also call the especial attention of all engineers to the connection of stringers to floorbeams. The drawing this girder is copied from calls for turned $^{15}/_{16}$-in. bolts. In my judgment and experience I have found it impossible to make a first-class fit with a straight turned bolt in a place when there is so much motion as in a bridge, unless you make it a driving fit. The bolt I have shown in this joint is a tapered bolt $^{1}/_{16}$-in. to the inch and has no head. The thread is chased in the lathe or cut in an improved turret lathe. I use a $^{5}/_{16}$-in. washer and jam nuts, the best piece of mechanism that can be designed for such a construction. A bridge such as I have shown should be assembled in the shop before shipment.

Yours truly,

Joseph H. Springer, Sr.

Galt House, Louisville, Ky., June 30, 1906.

## REPORT ON SEWAGE DISPOSAL FOR PATERSON, N. J.

After successfully fighting the proposed Passaic Valley trunk sewer for many years the city of Paterson, some months ago, engaged Messrs. Hazen & Whipple, of New York City, to report on the best available means of local disposal. Subsequently Mr. Geo. C. Whipple, Assoc. M. Am. Soc. C. E., proceeded to Europe to study the latest sewage purification practice there, particularly that of towns engaged in silk manufacturing. On Aug. 8, Mr. Allen Hazen, M. Am. Soc. C. E., submitted to the aldermen of Paterson a report on the result of the investigations just outlined. In brief, Mr. Hazen recommends that Paterson join with other communities in the trunk sewer plan, provided there are no legal or political objections, and that purification works will not be required. If sewage works are a necessity, then Paterson might better install works of its own, using for preliminary treatment either septic, settling or chemical precipitation tanks, of one-half day's flow capacity, following these by percolating or sprinkling filters consisting of 10 ft. in depth of screened and washed broken 2½ to 1-in. trap rock, and completing the process by two or three hours of sedimentation.

In general, it will be seen, as Mr. Hazen himself states, that this plan is similar to the one now being carried out at Columbus and recently proposed for Baltimore (see article on the Baltimore plan elsewhere in this issue). At Baltimore, however, the secondary sedimentation may be followed by intermittent filtration, if the intent of the sewerage enabling act is fully carried out. The site recommended for disposal works, if Paterson builds such, is on the west side of the Passaic River, above the Dundee Dam, which in turn is just above Passaic. It is estimated that 500 acres of land would be required for the works, and the total cost of changing from the combined to the separate system of sewers and of the necessary pumping station, outfall sewer and sewage works, would be $2,400,000. Less than half this would be required for the sewage works alone.

Some portions of Mr. Hazen's report, embodying his discussion of the trunk sewer project and of the relation of the Paterson sewage to the Passaic River, may be quoted [from the Newark Advertiser, Aug. 8] as follows:

From a physical standpoint there is no good reason why the sewage of the Passaic Valley should not be discharged into tidewater, either in New York Bay as proposed, or in Newark Bay near the end of the Kill Von Kull. There may be legal or political reasons why such discharge cannot be allowed. If these matters can be adjusted, so that a free tidal discharge of crude sewage can be obtained, then clearly it is best for Paterson to join with the other municipalities in the construction of a trunk sewer. It is cheaper to carry the sewage to tidewater than to purify it.

If, on the other hand, legal or political objections to the discharge of crude sewage into New York Bay or Newark Bay should prevail, then it would be necessary to purify the sewage from Newark and the other cities using the trunk sewer before discharging it. If the sewage from the trunk sewer is purified, then, clearly, Paterson cannot afford to join with the other municipalities in the trunk sewer project. It will cost as much, or nearly as much, to purify the sewage below Newark as it will to purify it near Paterson; and the cost of building the trunk sewer to carry the sewage for so long a distance remains as an unbalanced or only partly balanced item, the cost of which Paterson can save by treating her own sewage.

Either the trunk sewer or local purification would completely serve the desired end of preventing the pollution of the Passaic River by Paterson, although in either case it is essential that the dye houses and other manufacturing establishments be required to connect with the sewers. The Passaic River cannot be adequately purified without doing this. The regulation of these connections is a new subject in America, and it will very likely require new laws to adjust this matter so as to do justice to all.

* * * * *

It is questioned whether or not New York has the legal right to stop the discharge of sewage at the point and in the way proposed. [Referring, evidently, to the possible attempt of New York to enjoin the discharge of sewage from the Passaic Valley into New York Bay.]

It is clear, however, that in case New Jersey should abstain from using the harbor because of New York's objection to the additional pollution, either voluntarily or through constraint, it would only be fair for New Jersey to make a corresponding effort to prevent sewage discharge on the New York side of the bay.

The New York harbor is clearly capable of receiving the sewage of a population very much larger than that now tributary to it without becoming objectionably contaminated, but there is a limit to the amount which can be discharged. If the city keeps on growing, the limit will be some time reached. If the New Jersey sewage is kept out of the harbor, then the limit will not be reached as soon, and New York sewage can be discharged for a longer interval without producing offensive conditions.

* * * *

Paterson's sewage is a contributing cause to a slight extent to the condition [river pollution] at Newark, but it is only to a slight extent. The river at Newark would be materially improved by stopping the discharges from Paterson; and if the lower discharges were removed, leaving only Paterson's, there would not be the slightest nuisance in the river opposite Newark.

It should be noted, in conclusion, that Mr. Hazen obtained the opinions of Mr. H. W. Clark, chemist of the Massachusetts State Board of Health, as to the best means of treating the sewage of Paterson.

## MISTAKES IN WATERPROOFING.*

By Edward W. De Knight.†

Mistakes in waterproofing are the result mainly of three causes: (1) Faulty design of the thing to be waterproofed; (2) use of improper materials; (3) imperfect application.

*Greatly condensed from a paper read before the American Society for Testing Materials, June 23, 1906.

†Manager Hydrex Felt & Engineering Co., 120 Liberty St., New York City.

The writer firmly believes that no material should be used for waterproofing which is not elastic or which becomes hard or vitreous.

Mastics (composed of asphalt or coal tar pitch mixed with sand, etc.) are more yielding for waterproofing than cement coatings. Yet experience shows that almost invariably even mastics will in cold weather crack clear through with any settling, or expansion and contraction. Burlap is frequently incorporated to prevent this from cracking; but experience also plentifully shows that this method—not the material, please note—is not dependable, because cracks will still occur and the burlap, being not waterproof, lets, of course, the water pass through.

An elastic waterproofing is not confined to one, but may be composed of many suitable materials. It may be described as follows:

It should resemble a membrane or skin; be in one sheet, absolutely impervious to water; be flexible, tough and elastic; be made of materials specially made to withstand the injurious action of water and all underground conditions. As many sheets or layers of this impervious membrane or skin should be cemented or veneered together as the conditions require. This stratum of waterproofing when in place must be independent of the surface or thing waterproofed, which may vibrate or settle, twist or crack, expand and contract, without in the least affecting it, exactly as is the hide of a horse or the skin of one's hand free and independent of the surrounding tissue, so that it may readily and naturally yield to every move of the body or the hand.

A common and serious mistake is in attempting to do waterproofing with incompetent, inexperienced men. The average contractor will try to do the work with his own men, usually ordinary laborers, or will sublet it to a roofer. Roofing is not waterproofing.

The preparation of the surface to be waterproofed—so that it be perfectly smooth, etc.—is important; also the careful protection of the waterproofing until it is completed and until the permanent protection is placed upon it. A very serious mistake is in not properly sloping a flat surface to drains. Water must be kept moving.

Every waterproofing specification should close with the strict injunction that the waterproofing must be done only by experienced and expert waterproofers.

## ENGINEERS' REPORT ON A COMPREHENSIVE SEWAGE PURIFICATION PLANT FOR BALTIMORE, MD.

By far the largest and most comprehensive works for the treatment of sewage yet proposed in the United States is outlined in a recent report made to the Sewerage Commission of Baltimore, Md., by Messrs. Rudolph Hering, Samuel M. Gray and Frederic P. Stearns, M.'s Am. Soc. C. E. The plan proposed includes septic tanks, sprinkling or percolating filters, settling basins and intermittent sand filters, in the order named, all of sufficient capacity to treat 75,000,000 gals. daily. The cause for proposing so elaborate sewage works is the fear that the discharge of sewage or effluent into Chesapeake Bay would injure the large oyster industry, which is of such economic value to Baltimore and vicinity.

Reports on sewage treatment were made in 1897 and 1899 by a previous sewerage commission.

For reasons which it is unnecessary to state here, further than that they involved among other things the possible damage to the oyster industry, the recommendations of the previous commission were not carried out, although legislative authority for a $12,000,000 bond issue for sewerage and sewage disposal was secured.

In April, 1904, the State Legislature passed another sewerage enabling act, authorizing a bond issue of $10,000,000, subject to approval by popular vote, and also the appointment of a sewerage commission to have charge of the design and construction of the proposed system. This commission, as appointed by the Mayor and City Council, numbered seven men, including Peter Leary, Jr., Brigadier-General, U. S. A., retired, and E. Clay Timanus, Mayor of the city, as member ex officio. In addition to the Board of Advisory Engineers already named, Mr. Calvin W. Hendrick, M. Am. Soc. C. E., was appointed Chief Engineer, and Mr. Harry W. Rodgers, Secretary. One of the provisions of the enabling act was as follows:

That said commission shall have no authority to construct and establish any sewerage system involving the discharge of sewage, as distinguished from storm water or ground drainage, into the Chesapeake Bay or any of its tributaries.

On asking for an interpretation of the foregoing provision of the act, the advisory engineers were informed that the Sewerage Commission had adopted the following resolution:

Resolved, That the effluent proposed to be discharged into the Chesapeake Bay or its tributaries in the system to be recommended by the engineers shall be of the highest practicable degree of purity.

In view of the unusual conditions imposed upon them, as indicated above, the advisory engineers secured permission to obtain the assistance of Messrs. Geo. W. Fuller, M. Am. Soc. C. E., Mr. H. W. Clark, Chemist of the Massachusetts State Board of Health, and Prof. L. P. Kinnicutt, of Worcester.

It should, perhaps, be stated that Baltimore has a partial system of storm sewers, but practically no sanitary sewers. The Board of Engineers advised that a separate system should be adhered to throughout, particularly in view of the necessity of pumping the sewage and of treating it on the elaborate plan already mentioned.

Under the proposed plan, septic tanks, with a storage capacity equal to eight hours' sewage flow, with a maximum depth of 12 ft. and a total area of about 400 × 800 ft., would be provided; also, some 30 acres of percolating filters, composed of broken stone averaging about 9 ft. deep; settling tanks sufficient for three hours' storage, with a depth of 10 ft., and a total area of about 300 × 500 ft.; and, finally, intermittent sand filters of a net area of 100 acres. It was concluded that the velocity of flow through the septic tanks should average about 4 mm. per sec., or 10 ins. per min. A fluctuating sewage depth of from 12 to 9 ft. was proposed, to aid in maintaining a uniform hourly rate of septic effluent to the percolating filters. For purposes of cleaning, and also for satisfactory control when the volume of sewage is small, it is recommended that the septic tanks be divided into five or "preferably more compartments." Sludge walls about 8 ft. high and floating scum baffles are recommended; also, tank bottoms sloping to sumps, with connections for cleaning, and water under pressure for flushing out the bottoms.

On the action of septic tanks, with particular reference to Baltimore conditions, the advisory engineers state:

So far as we are able to judge, the septic treatment under conditions to be expected at Baltimore will not materially affect the character of the settled sewage passing from the tanks. In fact, the septic treatment relates essentially to the condition and disposition of the sludge. The sludge may be allowed to accumulate for months or perhaps years. Under these circumstances the bacterial action occurs, and on an average probably more than one-half of the total deposited matter would be converted into a liquid or gaseous form. As the bacteria do not attack the solid mineral matter, it is the solid organic matter which is affected. The latter should be acted upon until it contains no more organic matter which will putrefy either in the septic tank or after its removal. The septic treatment, therefore, reduces materially the volume of sludge, and causes the latter, when the septic tanks are properly operated, to become practically inert mineral and humus matter. Septicization is practiced to best advantage when this effect upon the sludge is accomplished, and when the septic effluent shows a minimum effect of this bacterial action. We consider this latter requirement imperative and have so regarded the matter in this report, both as to the construction and operation of septic tanks.

This septic treatment results in the generation of a substantial quantity of gas composed principally of marsh gas. The rate at which the gas is evolved roughly measures the intensity of the bacterial action, and varies at different seasons of the year, depending largely upon the temperature and somewhat upon the kind of organic matter in the sludge and the bacteria present therein. This process continues during the winter weather, but is far more active during the warm season of the year. The gas thus evolved rises to the surface and at times carries up with it some of the sludge, thus forming a scum on the surface of the liquid in the basins. This scum is generally thicker in warm weather than in cold, and in many places it is almost absent during the colder season of the year.

The septic tanks are not provided with covers, as the latter do not facilitate the process except perhaps in climates far more severe than at Baltimore.

Based upon various experiences at numerous places, we have no reason to expect that objectionable odors would be encountered beyond a short distance from these tanks if the latter are well managed. The odors are carried the greatest distance on almost calm, muggy days in summer when there is no strong wind to disperse them. Under these conditions it is safe, in our judgment, to estimate that objectionable odors will not be carried to as great a distance as one-fourth of a mile.

The engineers express the belief that there would be deposited in the septic tanks about two-thirds of the suspended matter and one-third of the total organic matter, amounting to about 6 cu. yds. per 1,000,000 gals. of sewage, and that this septic sludge would contain 90% or more of water. By good management the sludge might be reduced by bacterial action about one-half, and still further consolidation in the tank to about 2 cu. yds. per 1,000,000 gals. The amount of water in the septic sludge would then be about 80%.

Sludge disposal on land is recommended in the report, apparently according to the same general plan as that followed at Birmingham, England, where the sludge is pumped onto land properly embanked to a depth of 8 or 10 ins., the water "allowed to disappear by percolation and evaporation" [and the remaining sludge finally plowed in].

The sprinkling or percolating filters would receive sewage from spray nozzles at the rate of about 500 gals. per sq. yd. per day (2,500,000 gals. per acre). The filtering material would be "fairly coarse broken stone," large enough to give "a free vertical circulation of air." Stone passing through a 2½ and retained by a 1-in. ring is suggested. A rather unusual depth of 9 ft. is proposed, on account of the unusual degree of purification required at Baltimore. It is thought that such filters would produce a non-putrescible effluent, at the same time removing about 70% of the applied bacteria and 90% of those in the crude sewage. The sewage would be distributed through conduits laid beneath the beds, with laterals about 13 ft. c. to c. and rising pipes 15 ft. c. to c., provided with special nozzles; the latter would work under a maximum head of about 7 ft., which might be varied in order to remove obstructions.

Ventilating and flushing galleries between the filter units are suggested. These would be some 4 ft. wide and 6½ ft. high, with manholes at intervals of about 100 ft. Cross-walls some 18 ins. high would be placed in these galleries some 13 ft. apart, "to facilitate flushing the bottom of the filter beneath and around the tile drains." For this purpose, filtered sewage would be piped to the galleries. Split tile underdrains, apparently forming a continuous or nearly continuous support for the material composing the percolating filters, are suggested.

It is thought that the effluent from the percolating filters would be "fairly clear," but that it "would probably contain some 30 to 40 parts per 1,000,000 of finely divided suspended matter." The effluent, as already stated, would be non-putrescible, "and the nitrates would be high," so that when discharged into water for dilution "there would be a continued oxidation of the organic matter and distribution of the bacteria of the original sewage."

It may be stated here that the proposed final discharge of the sewage would be into Back River, an arm of Chesapeake Bay. The engineers express themselves as of the opinion that the oyster beds in the bay would not be at all endangered by the discharge of the percolating filter effluent, if no further treatment were given to it, and that neither would there be any likelihood of "offence along the shores" of the river. Notwithstanding this belief, and acting in accordance with their instructions, the engineers worked out the proposed plan for final treatment by intermittent filtration. This plan was chosen because the use of "disinfectants, such as hypochloride of lime or of sodium, or sulphate of copper, would be prohibitively expensive." The use of mechanical filters, such as those used for treating water in mills, was given somewhat extensive consideration, but the engineers concluded that with their present knowledge of their applicability [in such an untried field] it was best to rely upon intermittent filtration. The intermittent filters proposed are essentially the same as those widely used in this country, with

the exception that, since they treat an effluent already largely clarified and purified, it is proposed to operate them at the high average rate, for sewage, of 750,000 gals. per acre per day. It is expected that, on receiving sewage at this rate, the sand surfaces of the filters will become clogged. It is thought that the sand could best be cleaned by removing, washing and replacing it, rather than by raking the surface. The estimated quantity of sand to be handled in this way would be about 2½ cu. yds. per 1,000,000 gals. of sewage filtered. It is expected that in manipulating the sand "the fullest possible advantage of machinery will be taken."

The estimates of cost of construction and operation of the proposed plant are as follows:

I. CONSTRUCTION.

| | | |
|---|---|---|
| A. Septic Tanks, Sprinkling Filters and Settling Basins. | | |
| Septic tanks, 25,000,000 gals. gross capacity, 10.5 ft. average depth, with inlet and outlet conduits and connections, baffles, drains, etc., complete | | $200,000 |
| Sprinkling filters, 30 acres net filtering surface, 9 ft. average depth, with foundations, drainage systems, distributing conduits from septic tanks to individual filters, pipes, gates, nozzles, etc., flushing arrangements, collecting drains, controlling house, office and laboratory, electrically operated gates, etc., complete | | 1,520,000 |
| Settling basins, 11,000,000 gals. capacity, 10 ft. average depth, complete, with connections from sprinkling filters | | 125,000 |
| Sludge disposal plant, including conduits, pumping stations complete for furnishing flushing and wash water, piping and reservoir, lighting plant and minor auxiliary works, complete | | 105,000 |
| | | $1,950,000 |
| Supervision and contingencies, 15% | | 292,500 |
| | | $2,242,500 |
| B. Supplementary Intermittent Filtration. | | |
| Conduit from settling basins to filter beds and main distributor | $83,000 | |
| Filter beds, 100 acres net filtering surface | 742,000 | |
| Sand washing plant and other auxiliary works | 80,000 | |
| | $905,000 | |
| Supervision and contingencies, 15% | 135,750 | 1,040,750 |
| Total, exclusive of land | | $3,283,250 |

II. ANNUAL OPERATION.

| | |
|---|---|
| A. Septic Tanks, Sprinkling Filters and Settling Basins. | |
| Supervision, chemical and bacteriological assistants | $10,500 |
| Attendants not included below | 13,000 |
| Disposal of sludge from septic tanks and settling basins | 8,000 |
| Average sum to be allowed each year to provide for cleaning the material in the sprinkling filters at 10-year intervals | 19,000 |
| Coal, supplies, repairs and renewals | 10,000 |
| | $60,500 |
| B. Supplementary Intermittent Filtration. | |
| Care of beds, conduits and grounds, including removal, washing and replacing of sand | 55,000 |
| Total | $115,500 |

In concluding their report, the engineers say:

We are aware of the fact that works of the type we have proposed have not yet been operated in our country on a large scale, although important experimental work has here been done. We are also aware that the works proposed at Baltimore constitute by far the largest undertaking of sewage purification in this country. However, enough plants of this type have been operated in Europe to furnish the necessary satisfactory precedents. After carefully weighing all of the evidence we are entirely satisfied that not one essential feature of the work is an experiment, that good management and operation will secure the desired results, and that these will be obtained at a less cost than with any of the older methods.

In a report by Chief Engineer Hendrick included in the same pamphlet with that of the advisory engineers, Mr. Hendrick gives the result of investigations of the location of oyster beds in relation to proposed sewage works. He says that "the nearest point at which any oysters are really cultivated is distant 14 miles" from the proposed plant, and expresses himself as of the opinion that the chance of pollution at such distant points is "a remote possibility." In view of this, and the high degree of purification to be expected from the works without the intermittent filters, and the fact that the construction cost of the latter would be more than $1,000,000, with an annual operating expense of $55,000 without interest, he strongly recommended that before beginning construction of intermittent filters a year's interest on their estimated construction cost, or as much thereof as might be necessary, be used in establishing a testing station. Such a station would be an obvious advantage in other ways also. Mr. Hendrick was subsequently authorized to build a testing plant.

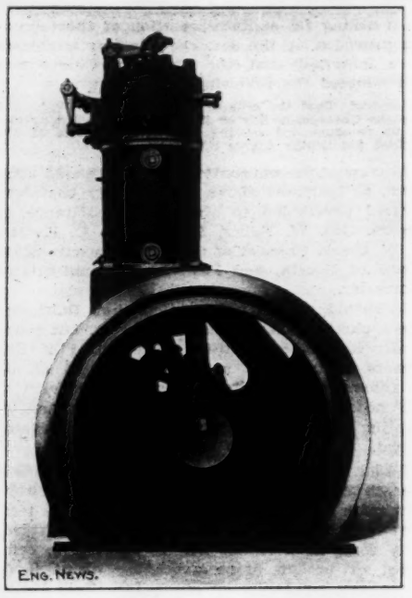



Fig. 1. A Single Acting Gas Engine Fitted with Ramsey Crank Mechanism.

## THE RAMSEY CRANK MECHANISM FOR SINGLE-ACTING INTERNAL COMBUSTION ENGINES.

The Ramsey crank mechanism is a device for increasing the efficiency (thermal, mechanical and total) of single-acting internal combustion engines.

In the ordinary engine the center line of the crank shaft is placed in line with the central axis of the cylinder and the connecting rod is usually about five times the length of the crank, since a shorter rod introduces excessive cylinder friction due to its sharp angularity during the power stroke. The Ramsey mechanism comprises a connecting rod approximately 3⅜ times the length of the crank, the central axis of the cylinder being located above the center line of the crank shaft, a distance equal to the length of the crank. The effect of this design is to increase both the length of the piston stroke, for the same length crank, and the proportion of crank circle during which effective pressure is applied to the crank. An engine fitted with this mechanism is shown in Fig. 1.

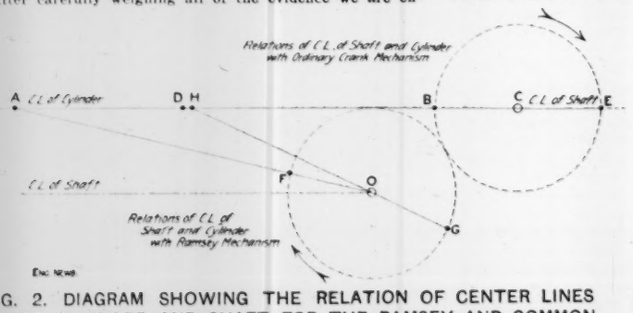



FIG. 2. DIAGRAM SHOWING THE RELATION OF CENTER LINES OF CYLINDER AND SHAFT FOR THE RAMSEY AND COMMON STYLE OF CRANK MECHANISM.

In Fig. 2, AB and BC represent the position of an ordinary connecting rod and crank at the beginning of the power stroke; DE and EC represent their positions at the end of the power stroke. AD therefore represents the piston stroke, which is equal to the diameter of the crank circle. During this stroke the crank rotates through 180°. AF and FO represent the positions of the connecting rod and crank at the beginning of the power stroke when the Ramsey crank mechanism is used, while HG and GO represent the positions of the same connecting rod and crank at the end of the power stroke. AH therefore represents the piston stroke, which exceeds by about 5.25% the diameter of the crank circle, while the crank pin has been driven from F to G, a distance which equals 192° of the crank circle, or 12° more than one-half the circle. The effect of this longer piston stroke is to increase the expansion of the gases, which increases the power delivered by an engine, as well as its efficiency and economy.

When an engine, fitted with ordinary crank mechanism, stands at dead center, the angle between the connecting rod and the central axis of the cylinder is zero. The only friction between the piston and the cylinder, therefore, is due to the weight of the piston. After passing the dead center, however, the angle rapidly increases until the crank has rotated through 90°, when it decreases to zero in the next quadrant. After the crank has rotated through 30° to position B, Fig. 3, the angle between the axis of the cylinder and connecting rod equals 6°; when D is reached it is 10° +, while at F the angle reaches its maximum value of 12°. At H it has decreased to 10° + and at F to 6°, passing through zero at dead center. Since the friction between the piston and the cylinder wall is the result of the angular thrust exerted by the connecting rod, therefore, the greater the angularity —pressure and velocity considered—the greater will be the friction.

Fig. 4 shows the conditions of angularity when the Ramsey crank mechanism is used. With the engine standing on dead center, AB, the angle between the connecting rod and central axis of the cylinder is 13°. As the crank rotates this angle rapidly decreases, instead of increasing as in the case of the ordinary mechanism, until at D, when the crank has rotated 30°, it is only 5°. At F it has decreased to 1°, the piston having reached point E. Between points E and G the piston is traveling at its maximum speed, while the crank rotating from F to H is in the most favorable position for transmitting power, since its angularity is practically zero. For positions H, K and L the angularity is ½°, 4° and 10° respectively. When point O is reached the crank has rotated through 180° and the angularity has increased to 21°, while at the outer dead center P Q it is 25°. Little friction is caused, however, by the angularities at these points, since comparatively slight pressure is being exerted on the piston and the distance traveled by it is small.

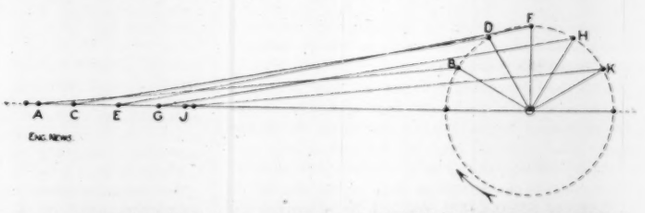



FIG. 3. DIAGRAM SHOWING VARYING ANGULARITY OF CONNECTING ROD WHEN THE COMMON CRANK MECHANISM IS USED.

The differences in cylinder friction, caused by the two crank mechanisms, is graphically shown in Fig. 5, the solid lines A referring to an engine equipped with the Ramsey crank mechanism, and the outline B to an engine equipped with the common crank mechanism, both engines having a 5-in. crank. The figures at the end of the respective lines show (in inches) the distance traveled by each piston, while the connecting rod is at an angle less than that indi-

cated. The most favorable angularity at which the ordinary crank mechanism has any considerable piston travel is seen to be between 6° and 9°, but even at this angularity the piston travel with the Ramsey mechanism is three times as great.

A feature of the Ramsey crank mechanism is the sluggish movement imparted to the piston at the beginning of the return stroke, thus making it possible to exhaust the burnt gases with considerably less back pressure than that which is inevitable in an ordinary gas engine. This sluggish movement of the piston is due to the

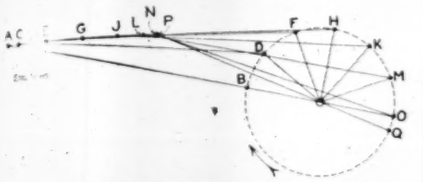



Fig. 4. Diagram Showing Varying Angularity of Connecting Rod When the Ramsey Crank Mechanism Is Used.

increased stroke obtained by using the Ramsey mechanism, the crank rotating through 60°, while the piston travels from D to H, Fig. 2, and back again. Moreover, this increased stroke and sluggish movement makes possible the use of an auxiliary exhaust port, since there is ample time for both the auxiliary and main exhaust to be operated after a power stroke equal in length to the full diameter of the crank circle has been completed. When the piston has passed the point of its sluggish movement it returns to the end of its stroke very rapidly. This rapid return of the piston during the compression of the fresh gases minimizes the loss of heat by radiation due to compression, thus increasing the temperature and pressure in the cylinder at the time of ignition with a corresponding increase in the initial pressure of the power stroke.

The Ramsey crank mechanism can be adapted to any single-acting internal combustion engine without interfering with the design of other parts. Moreover, it reduces the cost of the connecting rod forging and the length and weight of the completed engine.

A series of tests were made on a 9½ × 14 in. vertical gasoline engine fitted with Ramsey crank mechanism, which showed the fuel consumption to be from 1/10 to 1/11 gal. gasoline per HP.-hr. The total efficiency of the engine ranged from 24.1% to 25.9% when working under brake loads varying from 22 to 30 HP., as against an efficiency of approximately 19% for a similar engine fitted with ordinary crank mechanism.

The Ramsey crank mechanism is the invention of Mr. Robert H. Ramsey, of Philadelphia, Pa.,

Fig. 5. A Chart Showing the Differences in Cylinder Friction Due to the Ramsey and Common Crank Mechanisms.

and is covered by patents in the United States and foreign countries. The domestic patents are controlled by the Ramsey Engine Co., 472 Bullitt Bldg., Philadelphia, Pa., who will issue licenses to manufactures of single-acting engines in this country.

A FIRE AT THE INTERNATIONAL EXPOSITION at Milan, Italy, caused damage to the extent of some two million dollars on Aug. 3. It completely destroyed the sections devoted to the decorative arts of Italy and Hungary and those of the architectural exhibits of the same countries. The origin of the fire is attributed to an electric short-circuit.

A MUNICIPAL WATER SUPPLY FOR SAN FRANCISCO is to be considered and reported on by a board of three engineers appointed by Mayor Schmitz and approved by the Board of Supervisors, as follows: Major C. H. McKinstry, U. S. A., M. Am. Soc. C. E., 91 Flood Bldg., San Francisco, Cal.; Prof. C. D. Marx, M. Am. Soc. C. E., Stanford University, Cal.; and Mr. A. M. Hunt. Municipal ownership was one of the recommendations made recently by the special committee on water supply appointed after the earthquake.

BIDS FOR THE NEW CROTON FALLS RESERVOIR, opened at the office of the Croton Aqueduct Commissioners, New York City, on Aug. 7, showed seven bidders for the contract, of which A. G. Vermilye, of New York City, was the lowest, at $2,817,511. Under the specifications the work must be completed within 32 consecutive months from the month the contract is awarded. The specifications call for the construction of a main dam of cyclopean masonry, about 1,000 ft. long and 165 ft. high, and a waste weir about 700 ft. long; also a diverting dam of rolled earth, with a masonry core wall about 1,100 ft. long and 50 ft. high, and a waste weir about 1,000 ft. long. Mr. Walter F. Sears is Chief Engineer of the Croton Aqueduct Commission.

THE VIOLATION OF THE INTERSTATE COMMERCE laws in regard to rebates has been punished, in the case of the Atchison, Topeka & Santa Fe Ry. Co. and the Colorado Fuel & Iron Co., with a fine of $15,000 imposed upon each by the Federal Court of the District of New Mexico. It is claimed that the practice was intended primarily to develop the coal industry in Colorado and New Mexico, and that the violation of the law on the part of the officials was technical rather than criminal.

A REINFORCED CONCRETE HANDBALL COURT has been built on the grounds of Columbia University, New York City. The court wall is 2½ ins. thick, and is 80 ft. long by 15 ft. 6 ins. high. Both sides are used for play. On each side, at intervals of 20 ft., a triangular buttress, projecting about 10 ft. at the base, braces the wall; the buttresses are 2½ ins. thick, like the wall, but contain no reinforcement. The metal in the wall is Truss Metal Lath, measuring 1-in. out to out; the concrete is a 1 : 3 Portland cement and sand mixture, and contains no stone. The construction work was done in the same way as regular partition construction where Truss Metal Lath is employed. The lath is used in sheets 28 ins. wide by 90 ins. long, butted and wired at the joints. Temporary supports put up on one side of the wall support the lath, while two coats of the cement mortar are applied to the opposite side; after this side has set the supports are removed and this side is similarly plastered. The form of the lath is such as to allow the mortar to penetrate and join with the mortar of the other side, but it is probable that no cohesive bond is secured between the two sides. The faces were finished with a 1 : 1 mortar, worked on with steel trowels. This face work was done on the day after the body concrete had been placed. This court wall was built by day labor by Columbia University.

A GARBAGE AND REFUSE INCINERATING PLANT for Columbus, O., has been authorized by the City Council, and also a bond issue of $290,000 for the plant and accessories. The latter, we understand, will include equipment for collection. Mr. John H. Gregory, Assoc. M. Am. Soc. C. E., is engineer in charge, and Mr. Henry Maetzel is Chief Engineer of the Board of Public Service. An interesting and valuable report on garbage disposal at Columbus by Mr. Gregory was abstracted at length in our issue of March 15, 1906.

THE WATER SUPPLY of Rogers Park (Chicago) is at present a source of complaint on account of sewage pollution. This pollution results from the maintenance of sewers which discharge along the lake shore, and is due to the failure of the city to complete the northern section of its intercepting sewer system. The delay in this work, however, is in part the result of litigation over the contracts and the attempt of the city to do the work by day labor instead of by contract, which attempt was finally stopped by a court decision. The district is supplied by the Rogers Park Water Co. under a contract with the city, the plant having been built before the district was included within the city limits. The supply is taken from Lake Michigan by an intake pipe about 1,200 ft. long. The pollution has existed for several years, but the present condition appears to be rather worse than usual, although the Health Department reports that the condition has been exaggerated. It has been suggested that the intake may be extended beyond the limits of the sewage pollution zone. Another suggested plan, for a temporary or emergency remedy, is to connect the Rogers Park distribution system with the city mains.

A DRAWBRIDGE WAS WRECKED BY A STEAMER at Duluth, Minn., on Saturday, Aug. 11. The bridge is a 491-ft. swing span crossing the Gate, a natural passage through Rice's Point which separates the inner harbor (St. Louis Bay) from the outer (Superior Bay); the bridge connects Duluth with Superior, Wis., and carries two railway tracks, two roadways and two sidewalks. It has two trusses, between which are the railway tracks; the floorbeams cantilever out beyond the trusses, carrying on the extension on each side a roadway and a sidewalk. The roadways and sidewalks have ordinary wood floors. The structure was built in 1898, weighs 2,000 tons, is rimbearing, and is turned by a 50-HP. electric motor; end-lifts, latches and rail-lifts are operated by a separate motor. At about 1 a. m. of Aug. 11 the steamer "Troy," a 6,000-ton steel freighter, approached the bridge and gave the regular three-blast signal for opening the bridge. When the bridge-tender had the bridge partly open the vessel struck the bridge about 20 ft. south of the center pier and wrecked it. The wreckage of the structure fell into the channels and blocked them for vessel traffic, a serious matter because most of the great traffic of Duluth-Superior originates in the inner harbor, St. Louis Bay. The responsibility for the accident is not clear. The bridge was fitted for very fast operation, as is shown by the fact that it was always reversed end for end at each operation. It was intended to open in 90 seconds. The bridge-tender states that the steamer was 500 to 600 ft. away when it gave the signal and he "at once started to open the draw." He declares that the bridge was about one-third open when the vessel struck it. The wrecked bridge is about two miles southwest of the Duluth ship canal, one of the two passages through Minnesota Point, the bar which closes off the outer harbor. The Duluth ferry-bridge, built in 1904, crosses the Duluth ship canal.

ALLOTMENTS TO THE U. S. RECLAMATION FUND have been adjusted by the Secretary of the Interior in accordance with recent estimates from the General Land Office as to the probable amount of this fund during the next two years. The aim has been to allot the fund to the projects where the work is now furthest advanced and where returns to the fund may be expected in the near future. It having been determined that at least $100,000,000 could be used to advantage in various parts of the arid West, as compared with about $41,000,000 likely to be available up to 1908, it is necessary that as much of the fund as possible be invested in works which will begin to yield returns to the fund at the earliest possible date, so that the money may be used over again as soon as possible for the construction of other works. In several of the projects a number of years must elapse before the works will be completed and produce a revenue, but in Nevada the work has advanced to a point where upwards of 50,000 acres are already under irrigation and from this land revenue may be expected soon. Other projects are nearing completion. The allotments as recently approved by the Secretary of the Interior now stand as follows:

| State. | Project. | Allotments. | Totals for State. |
|---|---|---|---|
| 1. Oregon. | Klamath (a) | $2,000,000 | |
| | Klamath (future) | 2,400,000 | |
| | Umatilla | 1,000,000 | $5,400,000 |
| 2. Arizona. | Salt River | | 4,539,161 |
| 3. Montana. | Huntley | 900,000 | |
| | L. Yellowstone | 2,000,000 | |
| | Milk River | 1,000,000 | |
| | Sun River | 500,000 | 4,400,000 |
| 4. Nevada. | Truckee-Carson | | 3,700,000 |
| 5. Nebr.-Wyo. | North Platte | | 3,330,000 |
| 6. Idaho. | Minidoka | 1,550,000 | |
| | Payette-Boise | 1,490,000 | 3,040,000 |
| 7. Cal.-Ariz. | Yuma | | 3,000,000 |
| 8. Wash'ng'n | Okanogan | 500,000 | |
| | Tieton | 1,250,000 | |
| | Sunnyside | 1,100,000 | |
| | Indian Res. | 100,000 | 2,950,000 |
| 9. Colorado. | Uncompahgre | | 2,500,000 |
| 10. Wyoming. | Shoshone | | 2,250,000 |
| 11. S. Dakota | Belle Fourche | | 2,100,000 |
| 12. N. Dakota | Pumping Projects. | 1,000,000 | |
| | L. Yellowstone | 700,000 | 1,700,000 |
| 13. Utah. | Strawberry Valley | | 1,250,000 |
| 14. N. Mexico. | Hondo | 336,000 | |
| | Carlsbad | 600,000 | |
| | Rio Grande | 200,000 | 1,136,000 |
| 15. Kansas. | Garden City | | 280,000 |

(a) The total allotted to the Klamath Project, Oregon, is $4,400,000; of this $2,000,000 is immediately available and $2,400,000 to be set aside for future funds.

A FOUR-CYLINDER SIMPLE LOCOMOTIVE has been built at the Collinwood shops of the Lake Shore & Michigan Southern Ry., and is the first four-cylinder balanced simple engine in this country. It is of the 4-4-0 type, with all cylinders connected to the first driving axle, and having two piston valves operated by Walschaert valve gear. The two cranks on each side are set at 180° and the single 10-in. valve chamber has only two steam ports, each connected to the two cylinders. The engine is for inspection purposes and has a cab extending to the smoke-box; this is fitted with seats on each side of the boiler and is entered by a winding stairway in front of the cylinders. The engineman's cab is partitioned off from the inspection room. The tender is peculiar in having hinged covers to entirely enclose the coal space

and so prevent the blowing of coal dust into the cars. The covers are hinged, so as to permit of filling the coal space. The principal dimensions are as follows:

| | |
|---|---|
| Driving wheels | 5 ft. 3 ins. |
| Truck wheels | 2 ft. 6 ins. |
| Wheelbase, driving | 9 ft. 0 ins. |
| Engine | 25 ft. 1 in. |
| Engine and tender | 48 ft. 4¼ ins. |
| Weight on drivers | 85,100 lbs. |
| Weight of engine | 126,000 lbs. |
| Boiler, wagon-top; diameter | 4 ft. 2 ins. |
| Boiler, rail to center line | 6 ft. 6 ins. |
| Working steam pressure | 180 lbs. |
| Fire-box | 31 × 96 ins. |
| Tubes, No., 187; diameter outside | 2 ins. |
| Tubes, length | 13 ft. 6½ ins. |
| Heating surface; tubes | 1,326 sq. ft. |
| Heating surface; total | 1,466 sq. ft. |
| Grate area | 21 sq. ft. |
| Cylinders (4) | 12½ × 20 ins. |
| Valves, 10-in. piston; travel | 4½ ins. |
| Valves, outside lap | ⅞-in. |
| Valves, lead and inside clearance | ⅛-in. |
| Smokestack, diameter | 1 ft. 4 ins. |
| Smokestack, height, rail to top | 14 ft. 10½ ins. |
| Coal in tender | 10 tons. |
| Water in tender | 4,300 gallons. |

STATE-AIDED HIGHWAY CONSTRUCTION IN Maryland was begun in 1905, under the direction of Mr. Walter Wilson Crosby, Chief Engineer of the Highway Division of the Maryland Geological Survey. Up to the close of 1905, 18 of the 23 counties of the State had petitioned for 150 miles of road improvements, and, after amendment by agreement, estimates had been made on 73.09 miles. Arrangements had been made, by the close of the year, for improving 40.46 miles of road in 14 counties, at an aggregate contract price of $212,593. At the close of 1905, 17½ miles of road had been completed and 5¼ miles were under construction. Some interesting statements regarding the crushed stone supply in Maryland may be quoted from Mr. Crosby's report for 1905, as follows:

The high cost of crushed stone for road purposes at the freight stations on the Eastern Shore has seriously interfered with the progress of permanent road construction in that section of the State. An effort has been made by this office to have this matter seriously considered by the transportation companies, with a view to a reduction in the cost of this material, and encouragement of road improvement thereby to the benefit of all concerned. On the Western Shore of Maryland, stone ranges in price from 50 cts. to $1 per ton on the cars at the crushers, and the freight rate varies from 25 cts. to 50 cts. per ton, according to the haul. For instance, stone from quarries in West Virginia and Western Maryland is delivered at freight stations between these points and Baltimore City, for from 80 cts. to $1 per ton; but on the Eastern Shore, although the price of crushed stone at Wilmington, Del., is about 45 cts. per ton, the freight rates are, for example, 50 cts. per ton to Elkton, a distance of 17 miles; $1.35 per ton to Queenstown, a distance of 80 miles; $1.10 per ton to Snow Hill, a distance of 133 miles; and $1.35 per ton to Vienna, a distance of 117 miles. These figures would make the cost of the stone at the stations vary from 95 cts. to $1.80 per ton, which accounts for the high estimates on the cost of stone roads for those sections.

The matter of lower freight rates has been brought to the attention of the Pennsylvania Railway System and is under consideration by it.

THE LARGEST INDUCTION MOTORS ever installed west of the Mississippi River have been purchased by the Anaconda Copper Co. These four motors will be used to drive the 10,000-ton concentrator of the Washoe smelter at Anaconda, Mont. Each motor is an Allis-Chalmers three-phase, 60-cycle, 1,200-HP. machine, operating at 360 r. p. m. and 2,080 volts. The notable feature of these units, outside of their size, is that they have squirrel-cage rotors, which is unusual for large motors. This style of motor was adopted because of the favorable conditions under which it will start (without load), and because of its higher power factor (92%), as compared with the wound rotor type. Their guaranteed full load efficiency is 91%. Moreover, as the mill runs continuously, the motors will be stopped and started only infrequently, and as the power system of the Missouri River Power Co., from whom the Anaconda Co. will purchase power, is large, the starting of one of these motors will not cause undue disturbance. The current will be transmitted to Anaconda from Helena, a distance of about 100 miles, by a double transmission line, operating at 70,000 volts, a substation at the works stepping it down to 2,200 volts. The motors are started through an oil-immersed six-step controller connected to an auto-transformer which lowers the line voltage at starting.

THE NEW STEAMSHIPS recently put in service between Liverpool and Montreal by the Canadian Pacific Ry. give that company a service of its own from England to Japan and Oriental ports, by way of its transcontinental railway and its steamers on the Pacific. The two new steamers for the transatlantic service are the "Empress of Britain" and the "Empress of Ireland," both built by the Fairfield Shipbuilding & Engineering Co., of Glasgow, and completed during the present year. The first of these was commenced in March, 1905; launched in November; given its trial trip in April, 1906, and started on its first voyage in May, 1906. The steamers are exact duplicates of each other. The hull is of double-bottom construction, and there are ten transverse bulkheads and eight decks. The length is 570 ft. over all, and 550 ft. between perpendiculars; beam, 65 ft. 6 ins.; depth, 48 ft.; loaded displacement, 23,120 tons. The sea speed is intended to be about 19½ nautical miles per hour. The maximum draft is 30 ft., but the normal service draft is 27 ft. 6 ins., with 6,800 tons of cargo and stores. The gross tonnage is 14,155 tons; net tonnage, 7,990 tons. Each ship carries 1,540 passengers, a crew of 373 (officers, engineers, stewards, etc., all included), and 5,000 tons of cargo. The twin screws are driven by a pair of four-cylinder, four-crank quadruple expansion engines, balanced on the Yarrow-Schlick-Tweedy system. The cylinders are 36, 52, 75 and 108 ins. diameter, with a stroke of 69 ins. Steam is supplied by six double-end and three single-end Scotch boilers, with an aggregate heating surface of 47,000 sq. ft. and 1,125 sq. ft. of grate area. The results on the high-speed trial trip over a measured mile and the long-distance trial trip were as follows:

| | "Empress of Britain." | "Empress of Ireland." |
|---|---|---|
| High-speed trip— | | |
| Ind. HP. | 18,750 | 19,200 |
| Speed, knots per hour | 19.78 | 20.00 |
| Long-distance trip— | | |
| Ind. HP. | 13,450 | 13,000 |
| Speed, knots per hour | 18.60 | 18.00 |
| Coal per I. HP. per hour | 1.33 lbs. | 1.37 lbs. |

A PORTLAND CEMENT PLANT with a capacity of 2,500 to 3,500 bbls. per day is to be built at Mason City, Iowa, utilizing a local limestone rock. The kilns, built by the Reeves Bros. Co., of Alliance, Ohio, will be 7½ ft. in diameter and 110 ft. long; pulverized coal will be used for fuel. All machinery will be driven by individual electric motors. The plant was designed by the Cowham Engineering Co., of Jackson, Mich., for the Northwestern States Portland Cement Co., of Mason City, Iowa.

## PERSONALS.

Mr. T. J. Hardman has been elected Chief Engineer of Construction of the Shreveport Northeastern R. R.

Mr. H. M. Robinson has been appointed Division Engineer of the Western Division of the Raleigh & Pamlico Sound R. R., with headquarters at Raleigh, N. C.

Mr. George A. Winsor has been engaged by the town of Framingham, Mass., to investigate the cause of the recent collapse of the Amsden Building, at South Framingham.

Mr. J. H. G. Wolf, M. Am. Soc. C. E., has been made Chief Engineer of the Tonopah Exploration Co. This company is installing water power and mills at Manhattan, Nev.

Mr. W. Edward Wilson, of Salt Lake City, Utah, has been appointed Secretary of the American Section of the International Waterways Commission, to succeed Mr. Louis C. Sabin.

Mr. J. M. Lee has resigned as General Manager of the San Antonio & Gulf R. R. to become General Superintendent of the Trinity & Brazos Valley Ry., with headquarters at Cleburne, Texas.

Col. David W. Lockwood, U. S. A., has been placed in Charge of the river and harbor works along the Hudson River from Troy to New York harbor, thence to Montauk Point, relieving Col. W. R. Livermore, U. S. A., who will remain in charge of the harbor work in New Jersey.

Mr. Theodore Horton, M. Am. Soc. C. E., has been appointed Consulting Engineer to the New York State Department of Health, Albany, N. Y. For some years past Mr. Horton has been with Hering & Fuller, of New York, latterly as Resident Engineer of the new sewerage system for York, Pa.

Mr. Geo. E. Bushnell, formerly Division Engineer of the Indianapolis & Cincinnati Traction Co., has been appointed Chief Engineer of the Indianapolis, Columbus & Southern Traction Co., with headquarters at Columbus, Ind. He succeeds Mr. John E. Jolliffe, who resigned to become City Engineer of Franklin, Ind.

Mr. Henry Stanley Renaud, member of the firm of Waller & Renaud, Consulting Chemists, has been admitted to the Bar of the State of New York as Attorney and Counselor-at-Law. Mr. Renaud will devote his attention, in connection with his work as consulting chemist, to chemical, techno-legal, chemico-legal, lego-mining and patent cases.

Mr. Halbert P. Gillette, M. Am. Soc. C. E., has been appointed Engineer of the Washington State Railroad Commission to estimate the cost of reproducing all the railways in the State. He has left New York City for Olympia, Wash., where he will prepare an estimate of the cost of each mile of track in the State, including about 3,000 miles of main and 1,500 miles of branch lines. This estimate will be based upon the cost of rebuilding the roads under present conditions, as regards prices of materials, rates of wages, etc.

Mr. Louis C. Sabin, M. Am. Soc. C. E., and Secretary of the American Section of the International Waterways Commission, Buffalo, N. Y., has been appointed Assistant Engineer and General Superintendent of the St. Marys Falls Canal. Mr. Sabin is a graduate of the University of Michigan and was formerly connected with the work at the Soo as Assistant Engineer. He commenced his career with the Chicago & Alton Ry. in 1887. In 1889 he became Inspector and U. S. Assistant Engineer for the construction of Poe Lock, Sault Ste. Marie. From 1898 to 1903 he was Assistant Engineer, U. S. Lake Survey, when he was made Assistant Engineer of River and Harbor Work at Sault Ste. Marie. He held this position until 1905, when he became Secretary and Special Disbursing Agent of the American International Waterways Commission.

## Obituary.

William Imrie, one of the founders of the White Star Line of ocean steamships, died at Liverpool, England, Aug. 7.

George W. Cady, an architect of Providence, R. I., died at his home in Longmeadow, Aug. 9. He was born Aug. 27, 1825, at Providence, where he always lived. He was a member of the American Institute of Architects.

Harry F. Stafford, City Engineer of Los Angeles, Cal., died at his home in that city on Aug. 3 from accidental gas asphyxiation. He was born at Petaluma, Sonoma County, Cal., in 1864, and obtained his engineering education at the University of California.

J. A. Frazer, General Manager of the Southern Pacific at Fresno, Cal., died suddenly at Brockville, Ont., Aug. 6.

Prof. Samuel Lewis Penfield, one of the eminent mineralogists of this country, died at South Woodstock, Conn., Aug. 12, of diabetis. He was born at Catskill, N. Y., Jan. 16, 1856, and graduated from the Sheffield Scientific School with the class of 1877. Later he became a student at Strassburg and Heidelberg, and, after his return to this country, received the degree of A. M. from Yale in 1896 and the degree of LL. D. from the University of Wisconsin in 1904. Soon after his return from Europe he was appointed Assistant Professor of Mineralogy at Yale, later being made a full professor, which position he held at the time of his death. He was a member of the National Academy of Sciences, besides numerous other scientific bodies in this country and Europe. Prof. Penfield was the author of "Brush-Penfield Determinative Mineralogy and Blowpipe Analysis (revised edition)," besides many papers on mineralogy, crystallography, etc., in the American Journal of Science and Arts.

## ENGINEERING SOCIETIES.

### COMING MEETINGS.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 15 to 17. Annual convention at New Haven, Conn. Secy., Frank P. Foster, Corning, N. Y.

THE NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 12-14. Annual Convention at Fabyan House, White Mountains, N. H. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN PUBLIC WORKS ASSOCIATION.
Sept. 14-15. Second Annual Meeting at Atlanta, Ga. Secy., W. H. Flint, Chattanooga, Tenn.

LEAGUE OF AMERICAN MUNICIPALITIES.
Sept. 26 to 28. Annual convention at Chicago, Ill. Secy., Jno. MacVicar, Des Moines, Ia.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 2 to 5. Annual Meeting at Birmingham, Ala. Secy., G. W. Tillson, Municipal Bldg., Brooklyn, N. Y.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.
Oct. 15 to 19. Annual Convention at Columbus, O. Secy., Bernard V. Swenson, 60 Wall St., New York City.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.—The Engineering Association Committee on Standardization has sent out data sheet No. 10, on "Flange and Tread of Wheels," to the general managers and engineers of the street and interurban railway systems. This sheet contains 15 different questions regarding present equipment and asks for suggestions for a standard.

INTERNATIONAL TRAMWAYS AND LIGHT RAILWAYS' UNION.—The international congress of the Union will be held at Milan, Italy, Sept. 17 to 21, headquarters being at the Grand Hotel de Melan. A reception to members of the congress and their wives will be given in the Salon de la Bourse on Sunday evening, Sept. 16, when badges, etc., will be given out. Monday, Tuesday, Thursday and Friday mornings will be devoted to business sessions and the reading of papers, while the afternoons will be given over to inspection trips and excursions, receptions being held in the evening. Wednesday there will be an excursion to Lake Majeur and to Varese. On Saturday there will be two excursions: one to Bergame and to Val Brembana, the other to Sondrio; members will be allowed to take their choice. The congress will close Saturday evening with a banquet given by the municipality of Milan.

# ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, August 16, 1906.

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## REVIEWS.

### Diverse Views of Municipal Ownership.

MUNICIPAL OWNERSHIP AND MUNICIPAL FRANCHISES.—The Annals of the American Academy of Political and Social Science, Vol. XXVII., No. 1, January, 1906. Bi-Monthly. Philadelphia, Pa.: The Academy. London, Eng.: P. S. King & Son. Paper; 7 × 10¼ ins.; pp. 258; one folding table. $1 per number.

MUNICIPAL OWNERSHIP IN GREAT BRITAIN.—By Frederic C. Howe, Ph. D. (In Bulletin 62, U. S. Bureau of Labor, January, 1906.) Washington, D. C.: Pub. Doc. Paper; 5¾ × 9 ins.; pp. 1—123; many tables.

MUNICIPAL OWNERSHIP IN GREAT BRITAIN.—By Hugo Richard Meyer, Author of "Government Regulation of Railway Rates." New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5½ × 8 ins.; pp. 340. $1.50, net.

MUNICIPAL OWNERSHIP IN GREAT BRITAIN.—By Everett W. Burdett. In May number of The Journal of Political Economy. Chicago: The University of Chicago Press. Paper; pp. 257-314. 35 cts.

Municipal ownership is presented from many viewpoints in the four publications noted above: the first publication includes a group of papers and notes on municipal ownership and allied topics both at home and abroad; the second is a commendable attempt to review, in brief compass, the whole subject of municipal ownership in Great Britain; the third, which also deals with Great Britain, is an able marshalling of a portion of the documentary evidence adverse to municipal ownership in England, Scotland and Wales. Most of the writers in "The Annals" have an intimate acquaintance with the specific localities of which they write. These papers and notes are largely descriptive of local conditions, past and present, including the history and present status of municipal ownership in European and American cities. The authors themselves generally believe in municipal ownership. Mr. Howe's studies are based on both the observations and opinions of other writers and on his own investigations in Great Britain. He is a strong believer in municipal ownership, as may be seen from his "The City," reviewed in this Supplement for Dec. 14, 1905, but he presents and discusses some of the opposing arguments. Professor Meyer is not only strongly opposed to municipal ownership, but he also goes so far as to maintain that public service corporations should have no more government control than any "ordinary trading and manufacturing industries." He is particularly averse to the idea that in return for rights to use the streets franchise-holding companies should share their profits with the city. He may or may not have seen for himself the actual operations of municipal ownership in Great Britain, but he appears to place far more confidence in the evidence revealed by official documents than in "the reports spread broadcast by 'birds of passage,' who study problems 'on the spot' without perspective or background." For the most part his drafts on "official documents" are for "evidence" on the anti-municipal side, only. A book on the same plan, but using the abundant documentary evidence against private ownership, would make an interesting companion volume, if written by as able a partisan as Professor Meyer. Mr. Burdett has drawn from both printed matter and his own personal observations, the latter in the summer of 1905. He is against municipal ownership, but is more temperate than Professor Meyer.

"The Annals" opens with an interesting, informing and, to a considerable extent, judicial review of "Glasgow's Experience with Municipal Ownership and Operation," written by Mr. Robert Crawford, who has held many official positions in behalf of the city of Glasgow, including a ten years' membership on the committee on street railways. The paper deals with the water, gas and electric lighting and street railway services of Glasgow. The next paper, by Prof. Percy Ashley, deals with "The Water, Gas and Electric Light Supply of London," all but the first of which are still under private ownership, as was the water supply until very lately. One of the most instructive papers in the group is on "Municipal Ownership and Operation of Street Railways in Germany," by Prof. L. S. Rowe, of the University of Pennsylvania. The experiences of Frankfort, Cologne, Munich and Nürnburg are given in some detail, including the steps towards municipalization and the financial results therefrom. Curiously enough, some of the German cities have felt compelled, in order to avoid deficits, to return from the zone or graded fare system formerly enforced by the companies, for maintaining which for profits, Professor Meyer condemns the British municipalities. The objection to the zone system, as viewed by the German cities and Professor Meyer, is that it perpetuates overcrowding in the central portions of the cities, whereas flat or uniform fares encourage wage-earners to move to the suburbs.

It is impracticable to outline the other papers in "The Annals," further than to say that they deal with transportation facilities in London, the municipal ownership movement in Chicago, revocable street railway franchises in Massachusetts, the gas, electric light, water and street railway services in New York City, the government and municipal services of Madrid, various aspects of American municipal government, the limitations imposed on municipalities by the constitutions of American States, and "The Relation of the American Municipalities to the Gas and Electric Light Service." The latter is a symposium provided by Professor Rowe, and local collaborators. Fifteen American cities are dealt with in a series of notes.

In a footnote Mr. Howe states that his paper, or report, is based on "a study of the leading cities in England, Scotland and Ireland during the summer of 1905, supplemented by two earlier investigations, 'on personal initiative.'" The official visits made in 1905 were supplemented by many "circulars of inquiry sent to more than one hundred local authorities in the United Kingdom." While Mr. Howe has been one of those "birds of passage" spoken of by Professor Meyer he has also consulted some of the very "official documents" approved and heavily drawn on by the latter, and much other literature, pro and con, on municipal ownership in Great Britain. His study is broader, more vital and human and less academic than the one by Professor Meyer. After a few words of introduction, Mr. Howe presents some of the motives for municipal ownership, its present scope, the criticisms of its opponents, and arguments in its defence. He then discusses the relationship between Parliament and the Board of Trade, on the one hand, and the municipalities on the other, after which he reviews, with the aid of statistical tables of charges for service, financial results and physical statements, the water, gas, electric light and street railway services. This review is followed by a few pages on "The British Municipality and Labor." Thus far the discussion has been general. It now changes to a consideration of the activities of a number of the larger British cities and towns. The paper closes with further statistical tables.

We consider it a most fortunate coincidence that Mr. Howe's paper and Professor Meyer's book appeared at practically the same time. Whatever one's attitude towards municipal ownership it will be well to read the two productions together.

Professor Meyer states, in his preface, that ever since 1892 he has been investigating

> the public regulation and the government ownership and operation of the so-called public service industries: the railway, the electric light, the electric power plant, and the telephone. . . . [He has] covered the United States, Great Britain, Germany and Australia.

Besides the present volume Professor Meyer has already published (see this Supplement for Nov. 16, 1905) a book on "Government Regulation of Railway Rates" and promises two other books, embodying the results of his studies.

The greater part of the book before us is devoted to British tramways and electric lighting plants, and the paralysis which, in the opinion of the author, these services and the whole electric industry of Great Britain have suffered through municipal ownership. Gas works receive little attention; water-works are not mentioned. A later treatment of telephones is promised.

The main counts against municipal ownership, besides those already mentioned, are that it curtails private industry; puts profits, in relief of taxation, before low rates, ample and efficient service; results, in the case of street railways, in a continuation of overcrowding, on account of the retention of the graded fare system and the failure of the municipalities to extend their lines or allow companies to extend theirs, into the suburbs; deprives manufacturers of cheap electric light and power; is responsible for the emigration or idleness of over 100,000 workingmen, that would be in demand if the electrical industries were developed as extensively in England as in America; gives municipal employees great political power, with results that are bad and threaten to be worse; and, with the aid of the Government Post Office, keeps the House of Commons under the thumb of the national civil service.

Far be it from us to deny that there is truth, sometimes much truth, in most of Professor Meyer's contentions. But, paradoxically, his contentions would be stronger if they were weaker. To begin with, the book from introduction to conclusion is conceived and framed like a lawyer's brief. Evidence on the other side (and every well-informed unprejudiced person knows there is plenty of evidence on both sides of this case) is practically ignored. Such unqualified and sometimes partial statements stimulate opposing arguments and suggest important factors that have been neglected. For instance, the comparison of street railway development in Great Britain and America is confined almost wholly to mileages or mileages and population, regardless of relative city areas in the two countries and the vast differences in other local conditions and in the habits of the people of the old and the new worlds. Again, the cheapness and excellence of the British gas service and the number of men engaged therein is ignored by the author when he urges that British cities are deprived of the benefits of extensive and low-cost electric service, and that British workmen must emigrate or remain idle on account of limited opportunities to work in electric light plants and the shops supplying goods for electric lighting.

The zeal of British public servants to conserve what they believe to be the interests of the municipalities is characterized as greed, magnifying public office and bureaucracy. The natural desire of local authorities to control their own streets, and to exclude or omit franchise companies from them is held up as a crying evil,

although in many American commonwealths the cities have even more complete control in such matters than do the British cities, while in the case of street railway companies and the placing of poles for electric wires private companies must often obtain the consent of abutting property-owners. The organization of municipalities for the promotion of their own interests in Parliament and elsewhere is also held up by our author as a most deplorable evil. Perhaps overmuch pressure is exerted in this way. But do not the private corporations join forces in their own interests? Can the British municipal associations compare for one moment in baneful effect upon legislation with the lobbies and other evil influences of American public-service corporations? Or is it likely that the army of municipal employees in Glasgow will ever bring municipal government in that city into such deep and black mire as the franchise companies and their political hangers-on have brought many of our American cities?

We are well aware that such questions go but a little way, if at all, towards disproving Professor Meyer's arguments, but they do tend to show his blind partisanship. Notwithstanding that partisanship, the weakness of some of his arguments and the many phases of the subject which he leaves untouched—partly, as he admits, for lack of "official evidence," in the form of blue books and the like—we commend Professor Meyer's book to all who wish to look at the other and generally unpopular side of municipal ownership. It is certainly a notable addition to the short list of anti-municipal-ownership books.

The article by Mr. Burdett has come to hand since the foregoing notes were written. The author covers some of the same ground as does Professor Meyer, but, of course, in much less detail. As Mr. Burdett does not believe in municipal ownership it is hardly to be expected that he will present much information to show its advantages or explain why it is so popular in Great Britain. He does pay a fine tribute to British municipal administration in general, but uses the facts and opinions thus presented to draw a strong contrast between British and American municipal government and to support his argument against municipal ownership in America.

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STAMPAGGIO A CALDO E BOLLONERIA.—By Gino Scanferla. Milan, Italy: Ulrico Hoepli. Cloth; 4 x 6 ins.; pp. 165; 62 figures in the text and 11 tables. 2 lire; American price, 60 cts.

A collection of notes, partly descriptive and partly in the way of practical suggestion, on drop-forging and the manufacture of rivets and bolts.

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LE COSTRUZIONI IN CALCESTRUZZO ED IN CEMENTO ARMATO.—By Giuseppe Vacchelli. Third Edition. Milan, Italy: Ulrico Hoepli. Cloth; 4 x 6 ins.; pp. 383; 270 figures in the text. 4 lire; American price, $1.20.

This work covers the entire subject of concrete, and in addition reinforced concrete is covered in condensed form. The book is intended as a handbook for Italian conditions. Cement and mortar occupy something over 100 pp., concrete (plain) about 130 pp., and reinforced concrete the same number. European practice alone is represented.

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CARBONI FOSSILI INGLESI, COKE, AGGLOMERATI. —By Guglielmo Gherardi. Milan, Italy: Ulrico Hoepli. Cloth; 4 x 6 ins.; pp. 586; four text illustrations, six folding maps in pocket, and numerous tables. 6 lire; American price, $1.80.

The core of this manual is a catalogue of the coals of Wales, England, Scotland, Ireland, subdivided according to basins or districts, veins, and uses, and containing analyses of all important veins. This is preceded by about 150 pp., on coal in general, analysis and calorimetry. The list of coals is followed by some foreign coal specifications, a chapter on coke and one on coal briquettes. Some tables are appended. The work is designed to be a reference manual for the Italian coal user, and seems excellently qualified for this purpose.

## Concrete Block Manufacture.

Reviewed by Arthur N. Talbot.*

CONCRETE-BLOCK MANUFACTURE.—Processes and Machines. By Harmon Howard Rice. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5½ x 9¼ ins.; pp. 152; 46 figures, mostly in the text. $2.

THE MANUFACTURE OF CONCRETE BLOCKS AND THEIR USE IN BUILDING CONSTRUCTION.—By H. H. Rice, Secretary, American Hydraulic Stone Co., Denver, Colo.; Wm. M. Torrance, M. W. S. E., Assistant Engineer Hudson Companies, New York, and others. New York: The Engineering News Publishing Co. London: Archibald Constable & Co., Ltd. Cloth, 6 x 9 ins.; pp. 122; illustrated. $1.50, net.

In the 26 short chapters in Rice's "Concrete Block Manufacture" the author has accomplished in a very satisfactory manner the avowed purposes of presenting in a simple way the well-established principles which practice has shown to be applicable to the manufacture of concrete blocks for building hollow walls and of considering the theoretical and technical questions of value in the manufacture and use of concrete blocks. The chapters on materials, particularly those treating the requirements for sand and stone and for the amount of water, are sound and to the point. The principles of proportioning and mixing are simply stated. The chapter on shape of blocks is a fair presentation of the properties of the various forms of blocks, as well as of the advantages of hollow walls over solid walls. In discussing processes, the possibilities of mechanical pressure block-making are described. Plasticity, facing, ornamentation and curing are chapter headings. The importance of care in curing, especially the necessity of providing sufficient moisture and of maintaining uniform conditions, is well presented. Various types of machines are described and illustrated. Plant arrangement and plant employees ars discussed. The chapters on qualities of concrete blocks and testing blocks sound a high key-note. The author holds high standards for the soundness, strength, density, impermeability, durability and fire-resisting quality of concrete blocks, and believes that it is to the advantage of the manufacturer to make thoroughly good blocks. He quotes the tests and requirements of the City of Philadelphia as standards of excellence. Manufacturers are properly taken to task for failures; and lack of knowledge of the nature and action of Portland cement and of the importance of the character and proportioning of the aggregate, and ignorance and carelessness in the manufacture and curing of blocks, are given as the most frequent causes of failure of blocks. Views of a variety of buildings built of blocks are given, and the principles of excellence of design are briefly considered. Building regulations are discussed, and the regulations for Philadelphia and Denver are given. There is a fair index.

Mr. Rice's book, though brief and somewhat general in its make-up, is a simple and commendable presentation of the principal features of cement-block manufacture, and will become a standard work. It should be in the possession of those interested in the manufacture or use of concrete blocks. The criticisms by the author of some of the evils which have attended the growth of the concrete-block industry are just, and the treatment of disputed points is fair. The form of statement is not dogmatic. Besides stating principles and reasons the results of experience and observation are freely given.

The second book is made up of the two prize papers and of extracts from nine other papers submitted in a competition for money prizes offered jointly by Engineering News and Cement Age. While the papers are necessarily brief, they are full of practical information from men experienced in concrete-block construction and are especially valuable because of the range of ideas and variety of viewpoints. The sixteen pages in the first prize paper, by H. H. Rice, cover the field of the manufacture and use of concrete blocks in a concise but comprehensive way, dealing with materials, mixing, manufacture, curing, facing, cost, and construction. The second prize paper, by William M. Torrance, gives considerable space to forms of blocks and to patent-rights and their worth, and is a discussion of value. It considers the cost of the product as compared with other materials. In connection with the discussion of engineering and architectural considerations, and of the success so far achieved in the industry, a number of views of buildings constructed of concrete blocks are given. The extracts from the other nine papers include the location, design and arrangement of plant, the forms and block, selection of materials, proportioning and consistency of mixture, methods of mixing, block machines and molding, curing, facing and coloring, ornamental work, waterproofing, cost and building construction. There is a good index, and also a copy of the regulations of the City of Philadelphia for manufacture, use and tests of blocks, and a list of manufacturers of machines and tools. The book on the whole is a many-sided practical treatise on concrete-block manufacture and construction. It should prove of value to those interested in this form of building construction.

It is fortunate that these two books on such an important application of concrete to building construction should be brought out at a time when this industry is attracting so much attention, for there has been a dearth of trustworthy literature on the subject. The merits of hollow concrete-block construction will give it a prominent place in building operations if the structural properties are properly looked out for and the esthetic and architectural possibilities are developed. These books may be expected to aid in correcting mistakes and avoiding failures and to assist in directing practice into the best channels, and thus to be of considerable service to building construction.

*Professor of Municipal and Sanitary Engineering and in charge of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.

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THE SCHOOL HOUSE.—Its Heating and Ventilation. By Joseph A. Moore, Inspector of Public Buildings, State of Massachusetts. Boston, Mass.: The Author. Cloth; 6 x 9¼ ins.; pp. 204; 65 illustrations in the text and 27 tables. $2.

The author has here embodied in convenient form a large amount of useful information based on his experience during the past eighteen years in inspecting public buildings in Massachusetts and "in supervising the construction of and testing the various methods of heating and ventilation, especially in school houses." He has also included further useful matter in the way of quotations from State laws and regulations on the construction and State supervision of public buildings. Some sixty-five pages are devoted to plans and descriptions of school houses and their heating and sanitary systems. The book is written in an easily understood, direct manner, and should be of great service to school boards and architects, particularly in those States where little official attention is given to the sanitation of school buildings. If school janitors have such things as private libraries, they might very profitably add this book to their shelves; and if they have not, it would constitute a good beginning of a library for them.

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MUNICIPAL BRIDGE AND TERMINALS COMMISSION. —Third Report to the Municipal Assembly [illegible]ing Preliminary Report of Messrs. Robert Moore and Albert T. Perkins to the Commission. St. Louis, Mo.: Robert Moore. Paper; 8¼ x 9¼ ins.; pp. 35; 18 folding plates.

The text of this preliminary report" was published in full in our issue of Aug. 26.

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## Erection and Operation of Refrigerating Plant.

Reviewed by J. C. Bertsch,* M. Am. Soc. M. E.

BAU UND BETRIEB VON KAELTEMASCHINENANLAGEN.—Tables, Data and Text Suggestions for Engineers, Public Officials, Owners of Refrigerating Plants, etc. By C. Heinel, Instructor in the Berlin Technical College. Munich and Berlin, Germany: R. Oldenbourg. Cloth; 5¼ x 8¼ ins.; pp. 251; 19 plates (two in pocket), 108 text illustrations and many tables. 12 marks; American price, $4.80.

The author describes his book as "numerical matter and hints for engineers, building departments and proprietors of refrigerating plants." He seems to presume that all those connected in one way or another with the buildings or machinery of refrigerating plants are masters in higher mathematics, thermodynamics and the reading of diagrams, for his work consists chiefly of tables and diagrams with which he attempts to solve thermodynamical problems by a graphic method of his own. It can not be disputed that his method furnishes simple means for the purpose stated, and that the book contains some valuable information. But it must be said at the very outset that the work of the author will be understood by a limited number of refrigerating engineers only, and hardly by a single building inspector or proprietor of a refrigerating plant. Most of the latter will be scared away from the book by looking at one of the diagrams, of which the book with 251 pages contains 71 besides the 19 large diagrams on inserted double page sheets.

The author states in the preface that he favors the graphic method of explaining matters. He condemns the method of some authors, who furnish figures without explanatory remarks just for the sake of filling their books with lengthy explanations in the text. But the author makes the same mistake in another form by furnishing all diagrams with explanatory remarks and supplying no text whatever. The reviewer is of the opinion that the author's mistake is worse than the one he condemns, because very few will ever find out how the diagrams are constructed. The author admits this by saying that, in order to understand the matter, one must first catch on to his graphical method. That is, one must first study the author's book, "Vereinfachte Darstellung thermodynamischer Aufgagen des Maschienenbaues mittels Schaulinien" (Simple explanation of thermodynamical problems of machine construction by means of graphical lines).

The numerical contents of the book (tables) are the same as are found in other good books on thermodynamics.

From the title of the book one might expect to learn how to build and operate refrigerating plants. But most of the space is occupied by theoretical subjects which are of little interest to those for whom the book is intended.

Pages 1 to 27 contain nothing but tables of the physical properties of gases and vapors of sulphur dioxide, ammonia and carbonic acid, which are graphically explained by 14 figures and 12 large diagrams. Then follow two diagrams showing the changes of the refrigerating medium during its passage through the refrigerating machine with and without consideration of the unavoidable losses, and the dependency of the cooling capacity on the temperatures in the refrigerator and condenser. Pages 34 to 51 contain tables and three figures for the determination of the theoretical sizes of compressors for the three principal refrigerants; of the heat losses through leaks and cylinder walls, and of the actual compressor volume needed for a given quantity of work. Pages 52 to 60 contain ten figures, two tables and one page of text showing the determination of the power required to drive a compressor.

So far the author has limited his work to tables and figures, giving no explanatory text. With page 62 the very short text begins. The heat transmission through materials used in the construction of refrigerating plants is briefly treated by giving the general principles of absorption, transmission and emission of heat, with the usual coefficients for different materials. The "Hints" begin on page 81, by enumerating the possibilities of operating a refrigerating plant with little but cold water, which is also shown by two diagrams. The prescription is this: Use an atmospheric condenser, the coldest or fresh water for cooling the liquid, and a large cooling tower for re-cooling the condensing water—all of which is a pretty old and well-known practice. Pages 84 to 95 contain some more hints with reference to the choice of the condensing temperature, cooling surface and velocity of gases within the pipes, etc., all of which is of little practical value. Pages 95 to 98 treat the well known methods of driving the compressors, and pages 99 to 101 give the requirements for the location of the boiler house and engine room, and for running an engine condensing or non-condensing. These hints may be welcome to the student or the novice in refrigeration, but for the practical man they are of no benefit. Every engineer or builder knows very well that the boiler should not be located next to an ice tank, or a steam pipe close to an ammonia or cold water pipe, and that an engine can only run condensing if sufficient water is at hand. Nearly all of the "Hints" are along that line.

Pages 102 to 126 are devoted to explaining the causes and signs of the absolute deficiency of refrigerating machines, as well as the faults of compressors as shown by the indicator. This part of the book is very commendable and of much value to the operating engineer. Pages 127 to 163 treat the test of a complete plant with reference to the actual performance of the machinery, power required, measuring the losses, the brine circulation, etc. The described method of testing a plant can only be carried out by an expert in mathematics, but not by a practical engineer, who cares little for the weight, density and humidity of the air, and who does not know what to do with psychrometrical tables. Pages 164 to 173 contain more hints for building refrigerated rooms and for producing the proper temperatures. Pages 174 to 177 contain instructions for obtaining estimates for the machinery, and on pages 178 and 179 the author gives some hints for the proper choice of the direct expansion or brine system for room cooling. He seems to have no knowledge of the American practice, for he states:

> The pipes for direct expansion must have much slope, and the gas of all coils must enter a large receiver without resistance. Lead the gas always upwards and the separated liquid back into the coils. For large installations the direct expansion system would save much work, but the successful application of this system has not yet been accomplished, owing to the wrong construction used, as the brine coils have simply been copied. Besides, a correct expansion valve has not yet been built.

In this country the direct expansion system with proper expansion valves has been in use with much success for the past 12 years, without sloping pipes and gas receivers.

With some instructions for sweet water cooling for breweries of different sizes the author concludes his work. The appendix of 60 pages contains nothing but tables giving the dimensions of pipes, fittings, pumps, motors, engines, boilers, etc., and is of little value.

*Refrigerating Engineer, Cascade Ave., West End, Atlanta, Ga.

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REPORT ON THE OPERATIONS OF THE COAL-TESTING PLANT OF THE UNITED STATES GEOLOGICAL SURVEY AT THE LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, MO., 1904.—Edward W. Parker, Joseph A. Holmes, Marius R. Campbell, Committee in Charge. Professional Paper, No. 48, U. S. Geological Survey. Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 x 11¼ ins.

Part I. Field Work, Classification of Coals, Chemical Work. Pp. 1 to 300; three plates (one in pocket) and 10 text figures.

Part II. Boiler Tests. Pp. 301 to 979; four plates and 93 text figures.

Part III. Producer-gas, Coking, Briquetting and Washing Tests. Pp. 980 to 1,492; six plates and 32 text figures.

The nature of this report is indicated by the title and sub-titles, above, and by the following quotation from the letter of transmittal:

> This report contains the full details of the installation of the plant, its operations, and the results obtained, with numerous illustrations by photographs, drawings, diagrammatic charts, etc. The plant was started Sept. 1, 1904, and was kept in operation, except for a shut-down at the Christmas holidays, until Feb. 25, 1905.

As may be judged from the foregoing, the report contains a large amount of information on the composition of various coals and the results obtained therefrom under test.


READY AUGUST 25th

**Railroad Location, Surveys and Estimates**

By F. LAVIS,
Assoc. M. Am. Soc. C. E.,
Resident Engineer Pennsylvania Railroad Tunnels.
Sometime Locating Engineer, Choctaw, Oklahoma & Gulf R. R., New York, Westchester & Boston R. R. Co., Etc.

Although several books have been written on railroad location, this is the first that combines detailed instruction on modern American methods of location with data on the estimating of quantities and unit prices. For example, tables and diagrams are given in this book, showing at a glance the number of cubic yards of masonry (concrete or stone) in standard railroad bridge abutments and piers of different heights. In like manner, the amount of materials in standard trestles of different heights, yardage in arches of different spans, the weights of steel in bridges, etc., are given. Contract prices for every variety of work are given to assist in making estimates. Every practical railroad engineer will recognize the value of such aids as these in making preliminary estimates of costs. The author is himself a railroad locating engineer of wide experience, and is at present Resident Engineer, Pennsylvania Railroad Tunnels. This book treats not only of estimating the cost of railroad work, but it is the most thorough treatise on the practice of railroad location that has yet been published. The various problems that occur in location are splendidly and profusely illustrated with line drawings. In fact, no other book on the subject contains half as many typical illustrations of location problems. Mr. Lavis goes into the details of the organization of parties, and camp equipment, the keeping of notes and mapping—in fact, every detail of field and office work is described. Since the first publication of Mr. Wellington's great work, no author has produced a railroad location book so full of original matter as this new volume. Wellington's book treats of the theory; this book by Lavis treats of the practice of location, and in addition it contains what neither Wellington's nor any other railroad book contains, namely, tables, diagrams and data for estimating the cost of railroad construction. The book is bound in cloth, 6 x 9 ins., and has about 250 pages, and 76 illustrations, including many folding plates. Its price is $3 net, postpaid.

READY IN SEPTEMBER

**Concrete and Reinforced Concrete Construction**

By HOMER A. REID,
Assoc. M. Am. Soc. C. E.,
Asst. Engr., Bureau of Buildings, New York City.

Before any of the three recent books on concrete was published, the manuscript of a book on reinforced concrete was submitted to us by Mr. Homer A. Reid. We asked the author to make additions to his work so as to cover the whole field of concrete construction, plain concrete as well as reinforced concrete. It seemed wise to do this, in view of the fact that there is so much in common between plain and reinforced concrete. The author agreed with us, and undertook the task of enlarging his work to cover thoroughly the whole field of concrete construction. In the meantime, three books on concrete have appeared, but not one can be truthfully said to discuss the two kinds of concrete with equal thoroughness, and, in fact, only one of the three books claims to do so. We believe, therefore, that "Concrete and Reinforced Concrete Construction," by Reid, is the only complete treatise on the general subject of concrete. This book is more profusely illustrated than any book on concrete or reinforced concrete yet published, which is a feature that will commend it particularly to the designing engineer. It contains, moreover, the most thorough discussion of the theory of reinforced concrete beams, columns, foundations, etc. Almost every class of structure built of reinforced concrete is illustrated in detail and described. For example, a reinforced concrete railroad trestle, with bents 50 ft. high, is among the latest additions to the book. Chimneys, water towers, bins, buildings, retaining walls, arches, etc., of the latest designs are shown, as well as forms, centering, etc. The author is an engineer experienced in concrete work, and is at present engaged as Assistant Engineer in the Building Department, New York City. Cloth; 6 x 9 ins.; about 600 pages.

*Send for Table of Contents*

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## The Protection of Metal Structures.

Reviewed by Robert Job.*

THE CORROSION AND PROTECTION OF METALS.—With Special Reference to the Preservation of Engineering Structures. By A. Humboldt Sexton, F. I. C., F. C. S., Professor of Metallurgy in the Glasgow and West of Scotland Technical College. Manchester, Eng.: The Scientific Publishing Co. Cloth; 5 × 7½ ins.; pp. 147. 5s., net; American price, $2.

Within a comparatively small compass this book gives a useful and generally accurate summary of present knowledge concerning the corrosion and protection of various metals.

In the first chapter the author states the combination of conditions necessary to produce corrosion. This statement paves the way naturally to the next chapter which details conditions which will retard or prevent corrosive action upon iron and steel. Mention is made of the different metallic coatings, such as zinc, tin, copper and nickel, which are in present use for protective purposes, as well as varnish and paints, and also a statement is made of the relative protective values of several common paint pigments. At this point the author leaves the recital of recognized fact and relies upon opinions which, unfortunately, are directly contrary to general experience. He says, for instance (p. 43), "Iron oxide paints are largely used and sometimes they are successful and at other times the reverse, this depending largely on the purity of the oxide used. Also, "a good oxide of iron paint will adhere firmly and show little tendency to peel off, but that this may be the case the pigment must be pure. An oxide of iron for paint should be specified to contain not less than 95% of ferric oxide," etc. Also, in speaking of graphite paint, we find "a real graphite paint, made with pure linseed oil and a graphite containing, say 90% of carbon, will be an excellent protective paint, whilst one with, say, a graphite containing 40% of carbon, will be almost useless," etc.

A number of years ago the reviewer began a very thorough investigation of various types of paints upon the Philadelphia & Reading Railway. The results of the service of the paints had proved beyond all question that in an oxide of iron paint durability in service bore no necessary relation to the proportion of sesquioxide of iron in the pigment, while in the case of graphite paints a corresponding condition was found to exist, and it was clearly evident that durability did not vary with the proportion of graphite. In fact, knowledge of the proportion of graphite or of sesquioxide of iron was merely an index of the relative covering capacity of the pigment and gave little idea of the relative efficiency in service.

The details of the investigation were presented to the Franklin Institute and appear in its journal of July, 1904. To summarize briefly, it was found that the durability of an inert pigment, such, for instance, as graphite or sesquioxide of iron, depended simply upon the relative fineness of the particles of the pigment, and bore no relation to mere coloring strength of the pigment. Further, it is common knowledge that in ordinary paints, coloring power beyond the proportion to give proper opacity to the layer, is of no more value than a similar bulk of any equally inert material of the same degree of fineness. In other words, the use of a pigment of sesquioxide of iron 100% pure would be little better than a waste of valuable material, since excellent opacity could be obtained with, say, 30% of the sesquioxide of iron together with 70% of an inert base of equal fineness. The additional 70% of sesquioxide of iron would merely add coloring intensity which was not needed, thereby increasing the cost without adding to the durability in service. Strangely enough, also, it was found that one of the most durable paints ever used upon our lines contained only 23% of coloring matter (largely sesquioxide of iron), while the remainder was merely a clayey base—but the excellent results there obtained were due merely to the fact that the pigment was inert and in an almost impalpably fine condition. In the above cases pure raw linseed oil with a small proportion of a good grade of Japan was used as the vehicle.

Another inaccuracy is found in the statement (p. 47); "As a rule, little fault is to be found with paints on these grounds (fineness of grinding), but any paint which shows lumps of solid material should be rejected." The last clause is certainly correct, but the inference that in any paint which is not in a lumpy condition the pigment is finely enough divided to ensure good service is entirely contrary to fact. As an example may be cited the fact that one of the structural paints referred to in the investigation already mentioned gave generally poor service owing to the relative coarseness of the pigment, although the paint was not lumpy and passed the usual tests for fineness then in effect in the specifications. It will thus be evident that a mere casual inspection of paint cannot be relied upon to give essential evidence regarding physical condition of the pigment; also it has not been the experience of the reviewer that "low price almost always means poor quality," for the reason that good physical condition can be obtained at very moderate cost through the use of an inert base held to definite physical properties.

The remaining chapters are concerned with an interesting discussion of the corrosive influence of gases and liquids upon the various metals, and contain much general information. The erratic corrosion of copper condenser tubes exposed to salt water is stated at some length, and seems to be somewhat analogous to the well-known differences which exist between iron and steel in the relative rates of pitting. Such problems as these give good indication of the present need of close investigation in the field of metallurgy.

*Analytical and Engineering Chemist, 404-406 Locust St., Philadelphia, Pa.

## Water Supply and Power Installations.

Reviewed by Allen Hazen.*

UBER WASSERKRAFT UND WASSERVERSORGUNGS-ANLAGEN.—A Practical Guide to Their Planning, Calculation and Construction. By Ferdinand Schlotthauer. Munich and Berlin, Germany: R. Oldenbourg. Cloth; 5½ × 8½ ins.; pp. 225; 39 figures in the text, and many tables. 7 marks; American price, $2.80.

This little volume covers the whole subject of the hydraulics of public water supply systems and of water power installations. The statement of principles is concise and clear. The reasons for providing distributing reservoirs, the method of computing their size, and the required sizes of pipes and various other parts of the works are stated with unusual clearness. The method of computing the sizes of pipes is interesting to American readers, because the pipes are so small and there is such a lack of attention to fire protection matters on the part of the well built cities, not subject to conflagrations, with which the author is familiar. A number of interesting tables and formulae are appended.

THINGS THAT ARE USUALLY WRONG.—By John E. Sweet. New York: Hill Publishing Co. Cloth; 5¼ × 7¾ ins.; pp. 49; 50 illustrations in the text. 50 cts.

To what extent are steam engines and machine tools intelligently designed, and to what extent are they mere copies of previous types? Prof. Sweet in this little booklet points out a number of details in which machine construction follows customary precedent and both builder and user are ignorant that the tool or engine might be so designed as to wear longer or produce more accurate work. The book is a reprint of a series of articles published in the "American Machinist," and any machine designer who has not given careful study to the suggestions as there made will be well repaid by securing a copy of the book.

DIE ABHAENGIGKEIT DER BRUCHLAST VOM VERBUNDE.—Und die Mittel zur Erhöhung der Tragfähigkeit von Balken aus Eisenbeton. By Fritz v. Emperger. Berlin, Germany: Wilhelm Ernst & Son. Paper; 7¼ × 10¼ ins.; pp. viii. + 47; 47 figures in the text. 3 marks; American price, $1.20.

The author describes in this pamphlet a series of reinforced concrete beam tests intended to show that adhesion between steel and concrete is lower than usually assumed. The paper has, apparently, been submitted for presentation before the Brussels Congress of the International Association for Testing Materials, but is here published independently.

*Consulting Engineer, 220 Broadway, New York City.

RAILWAYS OF THE CAPE OF GOOD HOPE.—Report of the General Manager, 1904. Cape Town, South Africa: Public Works Department. Paper; 8½ × 13 ins.; pp. 294; two pages of statistical diagrams.

The reports of the chief and district traffic managers, engineers and locomotive superintendents are given, and about 200 pages are devoted to tabulated traffic statistics. Experiments are being made with plantations for tie-timber, and the results so far are encouraging, as shown by a report from the Conservator of Forests. The financial results of operation were not very satisfactory.

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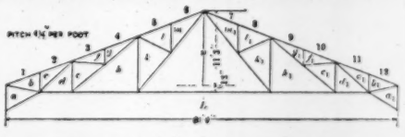

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## A Handbook for Reinforced Concrete.

Reviewed by Arthur N. Talbot.*

**BRAYTON STANDARDS.—A Pocket Companion for the Uniform Design of Reinforced Concrete. By Louis F. Brayton, Consulting Engineer. Minneapolis, Minn.: The Author. Leather; 4 x 6½ ins.; pp. 110; illustrations and tables. $3.**

This little handbook of reinforced concrete building design is in convenient form for office use. It contains about twenty tables of bending moments and moments of resistance of reinforced concrete slabs and beams, strength of reinforced concrete columns, weight of rods, amount of materials for making concrete, etc., together with cuts showing forms and types of design for building construction, and explanations of tables and calculations. The tables are in convenient form. It can hardly be expected, however, that the hope of the author, that the use of the book will render the design of reinforced concrete as easy for architects, engineers and builders as is the design of a steel structure, will be realized.

The tables for slabs and beams are based upon a balanced amount of steel and concrete to give a calculated stress of 500 lbs. per sq. in. in the concrete and of 16,000 lbs. per sq. in. in the steel, say a reinforcement of 0.7%. Many of the statements are somewhat obscure, so that the reader must exercise care to get the meaning of explanations and restrictions. The assumption that for square slabs reinforced in two directions one-half of the load may be considered to be taken in one direction and one-half in the other and then considered to be distributed uniformly is, of course, incorrect, and the other distribution given for rectangular panels is likewise not accurate. The value given for the bending moment for a slab supported on four sides contains a considerable error, perhaps (including the error in the assumed distribution of load) amounting to 50% for square slabs, and the moments and coefficients for "combination simple and continuous two-way types," etc., are also unreliable. It is not strange that with our present knowledge of slabs there should be errors of the kind mentioned.

The table giving necessary tension in steel in slabs ought to be convenient, as also the one for moment of resistance of slabs. The design of the "types" of beams might well have been given more space, especially on the matter of continuity. Web stresses are given little attention, the rule for placing a "shear loop" for each foot of length regardless of depth of beam being inadequate and not rational. In reinforced concrete columns, the use of 350 lbs. per sq. in. for concrete and 12,000 lbs. per sq. in. for steel, irrespective of the ratio of the moduli of elasticity, is absurd. In fact, the spacing and amount of the steel in the columns and also of the "column binders" can hardly be called good design.

The book, both in its literary form and in its typographical blemishes, bears the marks of amateur bookmaking, and the thinness of the volume is hardly commensurate with the price. The defects pointed out only emphasize the opinion that the time has not yet come when a handbook on reinforced concrete can be put out to be used in the manner that a handbook on timber or steel construction may be used. Besides, a thorough understanding of the fundamental principles of mechanics should form a part of the equipment of the designer of reinforced concrete.

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**CITY ROADS AND PAVEMENTS.—Suited to Cities of Moderate Size. By William Pierson Judson, M. Am. Soc. C. E., M. Inst. C. E., etc. Third Edition, Revised. New York: The Engineering News Publishing Co. London: Archibald Constable & Co., Ltd. Cloth; 5¾ x 8¾ ins.; pp. 197; illustrated. $2, net.**

The author has aimed to bring this book up to date without increasing its size by substituting new matter for old and by the use of foot notes. The volume presents in brief compass many of the most essential features of road and pavement construction.

*Professor of Municipal and Sanitary Engineering and in charge of Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill.


# READY IN SEPTEMBER

## Forest Mensuration

By HENRY SOLON GRAVES, M.A., Director of the Forest School, Yale University. 8vo, Cloth.

## The Economics of Railroad Construction

By WALTER LORING WEBB, C. E. 12mo, Cloth.

## The Occurrence and Properties of Clay and Its Distribution in the United States

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## Ice Formation, with Special Reference to Anchor-Ice and Frazil

By HOWARD T. BARNES, D.Sc., F.R.S. Can., Assistant Professor of Physics, McGill University, Montreal. 8vo, Cloth.

## The Building Mechanics' Ready Reference

*Carpenters' and Woodworkers' Edition.* By H. G. RICHEY, Superintendent of Construction U. S. Public Buildings. 16mo, vi + 226 pages, 118 figures. Morocco, $1.50 net.

## Symmetrical Masonry Arches

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## Notes on Military Explosives

By ERASMUS M. WEAVER, Major, General Staff, U. S. A. 8vo, cloth.

## Outlines of Practical Sanitation

For Students, Physicians, and Sanitarians. By Dr. HARVEY B. BASHORE, Inspector for Pennsylvania Department of Health; author of "Outlines of Rural Hygiene" and "The Sanitation of a Country House." 12mo, vi + 208 pages, 42 illustrations. Cloth, $1.25 net.

## Manual of Wireless Telegraphy

By A. FREDERICK COLLINS. 12mo, x + 232 pages, 90 figures, and 1 communication chart. Cloth, $1.50 net; morocco, $2.00 net.

## Elements of Mechanical Drawing

By ALFRED A. TITSWORTH, Rutgers College. Oblong 4to, Cloth.

## Notes on Geodesy and Least Squares

By C. L. CRANDALL, Cornell University. 8vo, Cloth.

## Problems in Surveying, Railroad Surveying and Geodesy

With an Appendix on the Adjustment of the Engineer's Transit and Level. By HOWARD C. IVES, Asst. Professor of Railroad Engineering at Worcester Polytechnic Institute, and HAROLD E. HILTS, of the University of Pennsylvania. 16mo, Morocco, $1.50.

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## An Album of Plate Girders.

TYPES AND DETAILS OF BRIDGE CONSTRUCTION. —Part II. Plate Girders. Examples of Constructed Railroad and Highway Spans. By Frank W. Skinner, M. Am. Soc. C. E., Consulting Engineer, Associate Editor "The Engineering Record," Non-Resident Lecturer on Field Engineering at Cornell University. New York: McGraw Publishing Co. Cloth; 6 x 9½ ins.; pp. 412; numerous text illustrations. $4, net.

The heavy task of bringing together a comprehensive set of sketches illustrating modern American plate-girder bridge practice has been carried out by the author with evident and admirable assiduity. The resulting product merits the appreciation of all structural engineers, as furnishing them a convenient reference to a great many typical and individual designs of the several constructive elements of railway bridge plate-girders. The book is essentially an album of drawings; the text is in the main restricted to the form of very condensed descriptive notes, which in many places are of true memorandum style.

The extent to which classification of the material has been attempted by the author is indicated by the following list of main divisions: General Features of Design, Construction and Service, 48 pages; Examples of Railroad Plate-Girder Spans, 74 pages, containing descriptions in order of span length of 28 bridges with spans from 25 to 170 ft. (American bridges up to 128 ft., and an old bridge from Bengal having a clear span of 170 ft., declared to be the longest railway plate-girder span on record); Details of Bearings and Splices, 105 pages, subdivided into Simple fixed end bearings, Simple sliding end bearings, Pocket expansion bearings, Plain roller bearings, Flange bearing pedestals, Pin bearings in cast expansion shoes, Pin bearings in riveted expansion shoes, Pin bearings in cast fixed shoes, Pin bearings in riveted fixed shoes, Deflection bearings, Miscellaneous bearings, Web and flange splices; 88 pages on Multiple Railroad Spans on Steel Towers; 60 pages on Highway and Special Spans; and lastly a chapter of 34 pages containing brief monographs on plate-girder design by H. S. Jacoby, J. A. L. Waddell, H. W. Hodge, J. V. W. Reynders, J. S. Deans, and J. B. French.

Beyond classifying the material to an extent fully indicated by the above summary, the author has done practically nothing in the way of digesting or analyzing the material he has gathered. He makes acknowledgment of this in the preface, thus:

> The examples presented have been selected because of their interest, and not necessarily because they are approved as models; the particular structures described may or may not be considered as in accordance with good practice. Criticism, in general, even when obvious, is avoided. The presentation of any detail does not necessarily imply that it is endorsed, but merely that it is considered typical or interesting as an example of actual construction. . . . The author's part has been largely that of compilation.

But not only is criticism avoided, but commendation and annotation are equally shunned, and this is perhaps more important to the reader. Notably inferior elements of design are usually recognized more easily than the highly meritorious ones; further, a detail which is a good choice in one case may not be the best in another case. It is therefore desirable to indicate, for the guidance of the reader, which designs are particularly good, or are "typical" or "standard," and in the case of designs having limited applicability to state what are their proper fields of use. The absence of such annotation, and indeed of any attempt at analytical treatment, makes the book a mere album of plate-girder details, as we have already characterized it.

The preceding refers to that part of the book written directly by the author. The monographs by prominent structural engineers, which form the last chapter, are an interesting supplement to the descriptive matter. They contain conservative opinion on various matters wherein the opinion of experience is the best guide, and advance many helpful suggestions.

AMERIKANISCHE EISENBAUWERKSTAETTEN. — A Report Compiled by H. Reissner, Constructing Engineer at the Royal Technical College in Berlin. Berlin, Germany: Richard Dietze. Cloth; 10¾ x 15½ ins.; pp. 75; 69 figures, partly in the text, and 30 tables. 12 marks; American price, $4.80.

Under a grant from the Berlin Royal Technical College, the author made a personal study of American bridge and structural shops, spending a year in drafting rooms and engineering offices here and another quarter in visiting works and plants. He presents part of the results of this study in the present volume. The volume describes the principal bridge and structural shops of the country, as to arrangement, organization and equipment. No similar monographs on the plants of Germany, the author's home country, has yet been written, at least not in recent years.

MARYLAND GEOLOGICAL SURVEY.—Wm. Bullock Clark, State Geologist. Baltimore, Md.: Pub. Doc. Paper; 7 x 10 ins.

Fourth Report on the Highways of Maryland. For the Period from Jan. 1, 1904, to May 1, 1905. By A. N. Johnson, Highway Engineer. (Special Publication, Vol. VI., Part III.) Pp. 281 to 320.

First Report on State Highway Construction. For the Period from May 1, 1905, to Jan. 1, 1906. By Walter Wilson Crosby, Chief Engineer, Highway Division. (Special Publication, Vol. VI., Part IV.) Pp. 321 to 415; five plates.

Of these reports the first deals with routine work, including advice, surveys and plans for the assistance of county highway authorities, and includes tables of tests of paving brick made at the laboratory of the department. The second report outlines the work done under the recently operative State aid act, following in a general way the plan of annual reports of other State road departments. The first contract for construction with State aid was made in June, 1905, and by the end of the year about 18 miles of roads had been completed.

STATISTICS OF CITIES HAVING A POPULATION OF 8,000 TO 25,000: 1903.—Bulletin 45, Bureau of the Census. S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9¼ x 11½ ins.; pp.

This bulletin, combined with a similar one (No. 20) for cities of 25,000 population and over, "constituted one of the decennial reports authorized by Section 7 of the Act of March 6, 1902, establishing a permanent Census Office." The classification and terminology used were arrived at after consultation with representatives of the National Municipal League, the American Economic Association and the Federation of Societies of Public Accountants. Besides the wide range of what may be termed the physical statistics of cities, such as those relating to fire departments, water and lighting plants and streets, there are many tables of financial statistics.


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## Water Softening.

Reviewed by George C. Whipple.*

WATER SOFTENING AND TREATMENT.—Condensing Feed Pumps and Heaters for Steam Users and Manufacturers. By William H. Booth, M. Am. Soc. C. E., Author of "Liquid Fuel and Its Combustion," "Smoke Prevention and Fuel Economy," "Steam Boilers: Their Design and Construction." New York: D. Van Nostrand Co. Cloth; 5½ x 8¾ ins.; pp. 308; 36 text illustrations and 42 tables. $2.50, net.

THE ANALYSIS AND SOFTENING OF BOILER FEED-WATER.—By Edmund Wehrenfennig, Mechanical Engineer, Chief Inspector of the Austrian Northwestern Railway in Vienna, in Collaboration with Fritz Wehrenfennig, Analytical Chemist, Director of Factories Eggenberg. Translated by D. W. Patterson, M. E. Second Edition, Thoroughly Revised. New York: John Wiley & Sons. London, England: Chapman & Hall, Ltd. Cloth; 5½ x 9¼ ins.; pp. 290; 171 figures in the text and two folding plates. $4, net; English price, 17s., net.

The appreciation of the importance of water softening is evidenced by the constant publication of new books and technical papers on the subject. The two works here listed are the most comprehensive of any which have recently appeared, yet it must be frankly admitted that neither gives an adequate treatment of the subject either from a theoretical or practical standpoint. It is strange that writers on water softening always find it necessary to lumber their pages with descriptions of forms of apparatus long since out of use and which have only a historical value to a few interested persons.

Booth's work is written from the standpoint of English practice. It treats not only of the softening of water, separation of oil, etc., but the more general subject of feed water supply. Half of the volume is devoted to air pumps, condensers, economizers, injectors, water coolers, etc., but little is said about boilers themselves. From those portions of the book more closely related to its title the American engineer will learn but little. The methods of analysis given are inadequate and the forms of softening apparatus described are evidently less efficient than those in common use in this country.

The German work by the Wehrenfennigs is somewhat more satisfactory, especially in its theoretical consideration of the subject. This, however, is not clearly written, and the "non-chemist," for whom the book is professedly written, would have great difficulty in making the water analyses described or in calculating the quantities of chemicals to be used. American practice in these matters is clearly ahead of the German. It is evident, however, that the authors understand their subject. They are emphatic in their condemnation of secret boiler compounds, and their statement that a properly softened water behaves better in the boiler than a natural water of similar degree of hardness is illustrated by analyses in an interesting manner. Many of the illustrations of the advantages of water softening are taken from the reports of the German and Austrian railways.

TIE PLATES. (Nouvelle Plaque d'Appui en Bois Injecté Armée de Chassis Metallique pour les Armements des Chemins de Fer).—By Joseph Borini, Director of Railways at Reggio dans L'Emilie. Reggio dans L'Emilie, Italy: The Author. Paper; 6½ x 9½ ins.; pp. 38; illustrated.

The purpose of this publication is to describe a compound tie-plate consisting of a block or plate of treated wood, upon which is set a malleable iron frame. The spikes or bolts pass through the metal and the wood, and the latter has only to support the rail, giving it a more elastic bearing than would be obtained with a metal tie-plate. The lateral pressure on the fastenings is taken up by the metal frame. These plates have been tried experimentally on the Reggio-Guastalla Ry.

IRRIGATION IN THE NORTH ATLANTIC STATES.—By Aug. J. Bowie, Jr., Agent and Expert. Bulletin No. 167, Office of Experiment Stations. A. C. True, Director. Washington, D. C.: Pub. Doc. Paper; 5¼ x 9 ins.; pp. 50; 7 illustrations in the text.

The number of small irrigation systems in use in the North Atlantic States for market gardens and meadows, as briefly described in this report, will be surprising to those who have supposed that irrigation was confined to the so-called arid West. Besides the descriptions of individual systems, there is a brief general section on the methods and costs of and the returns from irrigation. The few illustrations that accompany the report are well chosen and worthy of the attention of those having to do with irrigation.

COMMISSIONER OF HIGHWAYS, ONTARIO.—Annual Report, 1905. (A. W. Campbell, Commissioner.) Toronto, Ont.: Pub. Doc. Paper; 6½ x 9¾ ins.; illustrated. Part I. County Road Systems. Pp. 32. Part II. Township Road Management. Pp. 32. Part III. Bridge Construction. Pp. 48. Part IV. Road Construction, Pp. 48. Part V. Town Streets. Pp. 43.

Presumably for convenience and economy in distribution, the tenth annual report of the official named above has been issued in parts, as indicated. The various parts contain a considerable amount of information, much of which is of a popular and some of a technical character, on the subjects indicated.

ADMINISTRATION REPORT ON THE RAILWAYS IN INDIA.—For the Calendar Year 1905, by The Railway Board. (Alex. Duggan, Registrar Railway Board.) Simla, India: Pub. Doc. Stiff paper; 8½ x 13 ins.; pp. 235; two folding plates and numerous tables. 2s. 8d.; American price, $1.07.

The report proper reviews the development in construction and equipment, the improvement works, train accidents and flood damages, and other matters incidental to the operation of nearly 28,300 miles of railway. The numerous appendices deal in great detail with traffic and financial statistics, etc., and about 100 pages are devoted to summaries of the history and physical characteristics of individual railways.

RAILWAY STATISTICS.—Statistical Tables of the Working of Railways in Various Countries in 1904.—Compiled by J. D. Diacomidis, Engineer to the Egyptian State Railways. Cairo, Egypt: The Author. Paper; 9½ x 12¾ ins.; pp. 84. 20 francs; American price, $6.

These tables give the length, rolling stock equipment, train mileage, traffic and financial statistics, etc., for a number of railways in different parts of the world. The expenditures are classified for maintenance of way, equipment, traffic and general, and are given for each class in total and per mile of line and per mile run. While the figures for several individual representative railways are given for most countries, the railways of the United States are dealt with only in the aggregate, and are disposed of in one line in the tables; the figures for these railways, also, are for the year 1902. Separate tables give the totals of the several subjects for the railway systems of the various countries, and the summary shows a total railway mileage of 545,000 miles covered by the statistics.

PROCEEDINGS OF THE WESTERN RAILWAY CLUB.—J. W. Taylor, Secretary, 390 Old Colony Building, Chicago. Cloth; 6 x 9 ins.; pp. 344; illustrated.

This is the annual volume containing in permanent form the papers and discussions of the meetings held during the season of 1905-6.

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### Literary Magazines.

August being "Fiction" month for the magazines devoted more particularly to stories, there is nothing more to be said about them here. In the "Review of Reviews" for August Prof. Chas. Baskerville, of the College of the City of New York, reviews the conditions preceding the removal of the tax from denaturized alcohol and shows the beneficial results that may be expected from the use of cheap alcohol as fuel. In the same review there is an article on the "Opening of Shoshone Reservation," written by N. H. Darton, of the U. S. Geological Survey. To be available for agriculture, the land needs irrigation, he states. Extensive supplies of water can be obtained for this purpose from the Big Horn River and the Wind River. In the July "World's Work," Carroll D. Wright, commenting on the "Decline of Strikes" in the past year and the voluntary extension of the agreement between the bituminous coal operators and the miners, declares that the "trade agreement growing out of collective bargaining is the greatest hope for the country."

### Publications Received.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Chas. D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 × 9¼ ins.

No. 275: Slate Deposits and Slate Industry of the United States. By T. Nelson Dale, with Sections by E. C. Eckel, W. F. Hillebrand, and A. T. Coons. Pp. 154; 25 plates and 15 text figures.

COMMERCIAL DRY DOCKS.—By J. Mitchell Moncrieff, M. Inst. C. E. (Excerpt Minutes of Proceedings of the Northeast Coast Institution of Engineers and Shipbuilders, Vol. XXII., 1905-1906.) Address the Author (Consett Chambers, Newcastle-upon-Tyne, England). Paper; 6 × 9¾ ins.; pp. 123 to 169, and 191 to 194; folding and other plates and one text figure.

CONVICT LABOR.—Annual Report of the Commissioner of Labor, 1905. (Charles P. Neill, Commissioner.) Washington, D. C.: Pub. Doc. Cloth; 5¾ × 9¼ ins.; pp. 794.

COST REDUCTION OF REINFORCED CONCRETE WORK.—By E. P. Goodrich, M. Am. Soc. C. E. Read before the Association of American Portland Cement Manufacturers, June, 1906. Bulletin No. 11. Philadelphia, Pa.: The Association (C. Earle E. Bottomley, Asst. Secy., 1232 Land Title Building). Paper; 6 × 9 ins.; pp. 32; 24 illustrations in the text. For free distribution.

DISPOSAL OF WASTE WATER FROM CLOTH DYEING AND FINISHING WORKS AT RAVENNA, OHIO.—By Herman Stabler, Assistant Engineer U. S. Geological Survey. Ohio Sanitary Bulletin. April-June, 1906. Columbus, Ohio: State Board of Health (C. O. Probst, M. D., Secy.). Paper; 6 × 9 ins.; pp. 109 to 132.

ETUDE EXPERIMENTALE DU CIMENT ARME.—By R. Feret, Director of the Laboratoire des Ponts et Chaussées at Boulogne-sur-Mer. In "Encyclopédie Industrielle," begun by M.-C. Lechalas. Paris, France: Gauthier-Villars. Paper; 6½ × 10 ins.; pp. 777; 197 illustrations in the text, and many tables. 20 francs; American price, $6.

EXPERIMENTAL ENGINEERING AND MANUAL FOR TESTING.—For Engineers and for Students in Engineering Laboratories. By Rolla C. Carpenter, M. S., C. E., M. M. E., Professor of Experimental Engineering, Sibley College, Cornell University. Sixth Revised and Enlarged Edition. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5¾ × 9¼ ins.; pp. 843; tables, diagrams and 335 text illustrations. $6.

GEOLOGIC ATLAS OF THE UNITED STATES.—U. S. Geological Survey, Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Stiff paper; 18½ × 22 ins.

No. 138: Redding Folio. California. Pp. 14; four plates and one text figure.

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